STATE OF CALIFORNIA
EARL WARREN, Governor

DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 48 — JANUARY 1952 — No. 1

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

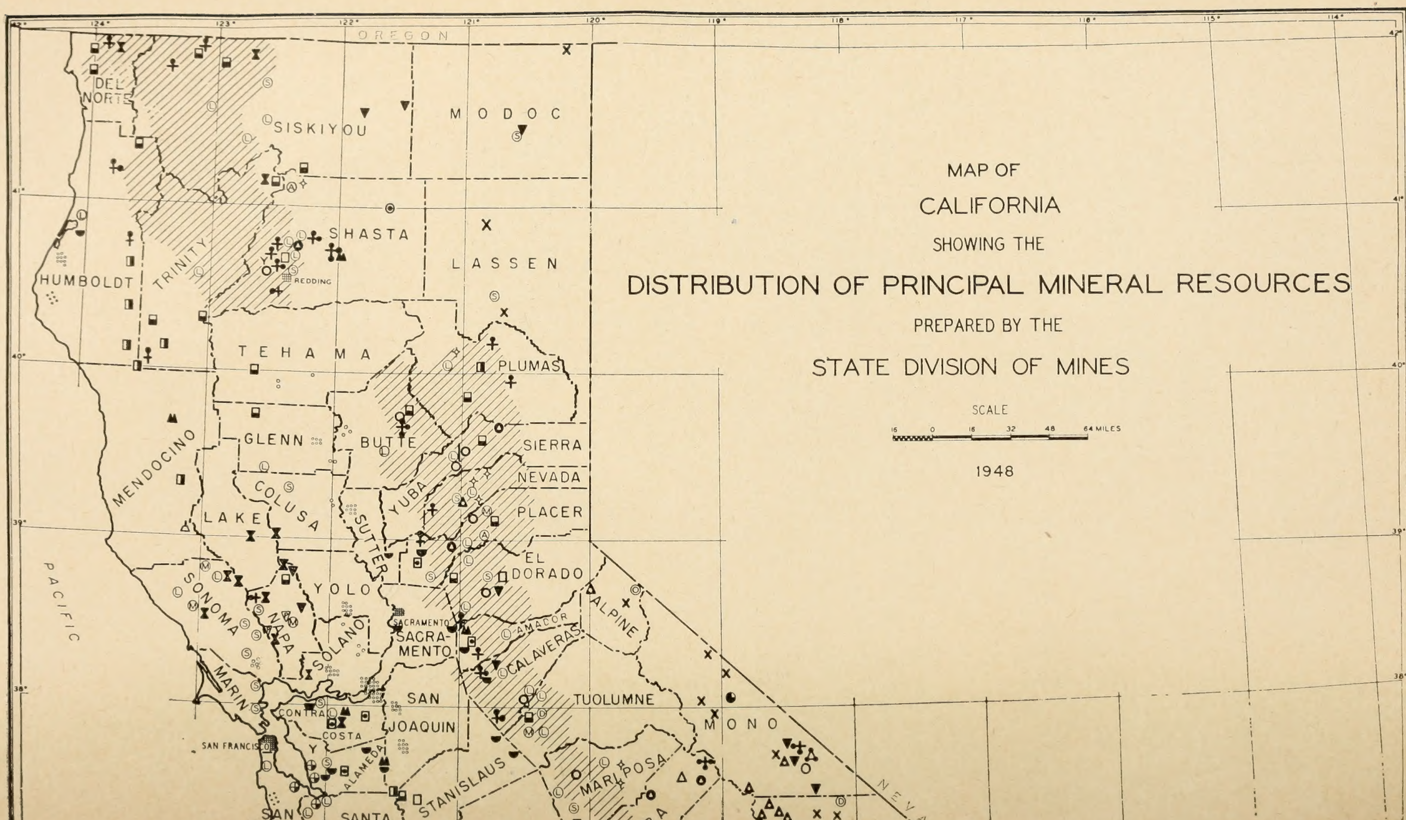
Headquarters
Third Floor, Ferry Building, San Francisco 11

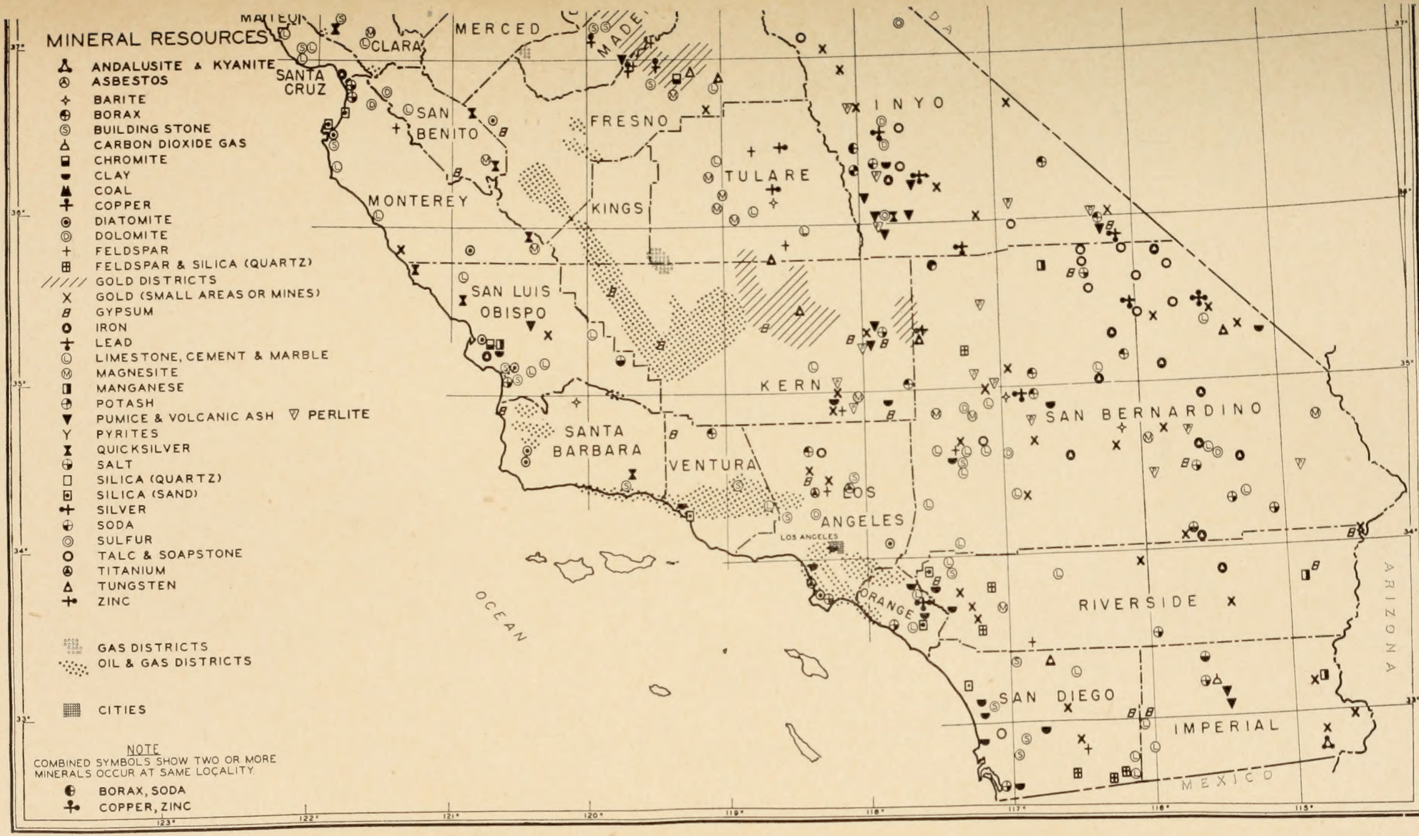
Branch Offices
State Building, 217 West First Street, Los Angeles 12
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
YUBA
PLACER
COLUSA
LAKE
SUTTER
EL DORADO
YOLO
SONOMA
NAPA
SOLANO
SACRAMENTO
SACRA-MENTO
ALPINE
AMADOR
CALAVERAS
MARIN
TUOLUMNE
MONO
SAN JOAQUIN
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SANTA
PACIFIC
124° 123° 122° 121° 120° 119° 118° 117° 116° 115° 114°
42° 41° 40° 39° 38°


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
SANTA CRUZ
CLARA
MERCED
MADERA
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

PLATES

MINERAL NEEDS AND PROBLEMS OF THE LEAD-ACID STORAGE BATTERY INDUSTRY IN CALIFORNIA

By Dudley Haskell *

OUTLINE OF REPORT

Illustrations

ABSTRACT

California's principal mineral contribution to the battery industry is the scrap metal and other materials contained in the batteries of the state's 4,000,000 or more automobiles and trucks. The state is the nation's largest consumer and largest producer of replacement batteries, and hence, is the largest consumer of minerals used in replacement battery manufacture.

The recent annual California production of 10,000 tons of primary lead valued at $3,000,000 is perhaps sufficient to meet the state's battery replacement requirements in view of the return of 75 percent of depleted batteries to smelters for secondary metal recovery.

California resources of talc, copper, asphalt, silver, silica, and synthetic rubber are sufficient to make the battery industry independent of out-of-state sources. Sulfur and barium sulfate needs have been partly met by California resources.

Minor amounts of antimony have been produced in the state, but known reserves are small and indicate that battery requirements of the metal must be continued to be fulfilled by imports.

---

* Research Chemist, W. P. Fuller and Company. Manuscript submitted for publication May 1951.

FIGURE 1. Grid casting machines. Lead-antimony grids are stacked in foreground. *Photo courtesy Hobbs Battery Company.*

INTRODUCTION

The increased use of the lead storage battery almost exactly parallels the growth of the automotive industry. A small proportion of lead storage batteries—about 9 percent of the total lead tonnage used per year—is used for purposes not connected with the automobile, such as in farm lighting installations, standby electric power stations, electric locomotives, submarine service and others. Some of the non-automobile batteries are the nickel-iron type[1] and others are the nickel-cadmium type.[2] Very few passenger cars, trucks, buses, tractors or other conveyances, however, make use of anything except the lead storage battery for starting, lighting and ignition purposes. It is logical, therefore, to observe the growth of the lead storage battery industry by reference to the statistics of the automobile industry. Fortunately for this purpose, very accurate records exist of the automobile industry since its inception about 1895; from about 1910 to the present time, it can be assumed that each motor vehicle contained one lead storage battery.

Ninety-one percent of all battery lead used annually is used in the automotive type of battery. Table 4 indicates the relative importance of the battery industry in various sections of the state. Battery manufacturers are concentrated in the Los Angeles and San Francisco Bay areas; battery production by counties is as follows in the order of importance: Los Angeles, Alameda, San Francisco, Orange, San Bernardino, San Diego, Sacramento and Kern.

Table 1. Annual mineral and raw material requirements of California battery industry.

	Pounds	Value	Mined in California and suitable for use in battery industry (lbs)	Produced in California (lbs)
Lead	67,000,000	$13,000,000	20,000,000	20,000,000
Antimony	2,860,000	1,054,000	negligible	
Asphalt	8,750,000			
Sulphur	5,100,000	40,000		1,360,000
Rubber natural and synthetic	6,500,000		all synthetic	
Talc	21,500,000	180,000	all	
Barium sulfate	85,000			
Tellurium				
Calcium	2,000			
Silver	34,000 ounces	30,000	724,771 fine ounces	
Aluminum	120,000	20,000	none	
Copper	2,000	440		2,000,000
Nickel	2,500			
Silica	50,000			
Carbon black	33,000	4,000		
Cotton fiber	2,000,000			
Diatomaceous earth				
Wood	3,000,000	1,163,000		
Ligneous products, special organic chemicals	66,000	10,000	6,000	

[1] Vinal, G. W., Storage Batteries, New York, John Wiley and Sons, 3rd ed., pp. 186-193, 1940.
[2] Willihnganz, Eugene, American Association of Battery Manufacturers Minutes, November 1948.

Table 2. Motor vehicle registrations in the United States.[1]

Year	Passenger cars	Busses	Trucks		Total vehicles
			Number	Percent of total vehicles	
1895	4	0	0	--------	4
1900	8,000	0	0	--------	8,000
1910	458,377	0	10,123	2.2	468,500
1920	8,131,522	0	1,107,639	12.0	9,239,161
1930	22,082,845	40,507	3,518,747	13.3	26,531,999
1940[2]	27,372,397	72,641	4,590,386	14.3	32,035,424
1945[2]	24,691,434	112,253	4,834,742	15.8	30,638,429
1948[2]	33,261,454	197,553	7,555,330	18.3	41,151,326
1949[2]	36,433,674	208,898	8,028,016	18.0	44,670,588
1950[2]	--------	--------	--------	--------	45,500,000 (est.)

[1] Data from United States Public Roads Administration, 1900 to date. Prior to 1900, estimated by Automobile Manufacturers Association.
[2] These surveys include vehicles owned by federal, state, and municipal governments. They do not include vehicles owned by the Department of War, the United States Navy and the United States Maritime Commission.

From the statistics in table 6, it is calculated that the average battery produced in 1948 contained 25.8 pounds of lead in the form of lead oxides and lead-antimony alloy, an amount about equal to that used in the batteries of larger passenger cars. The average amount of lead used is more than the amount used in the smaller and more numerous cars because some of the large truck and diesel batteries contain as much as 100 pounds of lead.

For purposes of calculation, the average battery would consist of the parts and quantities listed in table 7.

Value of Batteries

United States Department of Commerce figures show that the value of 6- and 12-volt batteries exported during 1948 was $7,283,000; the number exported was 621,408; the average value per battery, therefore, is established at $11.71. Because it is difficult to obtain figures on the average domestic price of batteries, this figure will serve as a guide for calculating the value of the battery business in the United States and in California. The chief item of value in a battery is the lead; another important battery metal is antimony. The relationship of the price of lead to the value of batteries in preceding years is shown in table 10.

The total in table 13 is a rough estimate of the value of the raw materials used in batteries manufactured in California in 1948. It is based on available data and serves to give an insight only into the extent of battery raw material requirements in California. Certain minor items,

Table 3. Motor vehicle registration in the State of California.[1]

Year	Passenger cars	Busses	Trucks	Total	Percent of vehicle registration in U. S.
1945	2,488,351	--------	360,278	2,848,629	9.30
1948	3,211,135	7,618	580,060	3,789,813	9.23
1950	4,076,484	--------	481,809	4,558,203	--------

[1] Data from United States Public Roads Administration.

Table 4. Registration of motor vehicles by counties in California, 1950.

Counties	Automobiles	Trucks	Total	Percent of state total
Alameda	265,183	25,685	290,868	6.37
Alpine	133	46	179	.004
Amador	3,677	772	4,449	.097
Butte	26,903	5,159	32,062	.70
Calaveras	3,810	877	4,687	.103
Colusa	4,905	1,704	6,609	.14
Contra Costa	99,992	9,075	109,067	2.39
Del Norte	3,359	961	4,320	.094
El Dorado	6,943	1,720	8,663	.19
Fresno	103,249	17,712	120,961	2.65
Glenn	6,692	1,846	8,538	.18
Humboldt	26,822	5,558	32,380	.71
Imperial	21,287	5,457	26,744	.58
Inyo	5,082	1,000	6,082	.13
Kern	85,230	13,966	98,196	2.15
Kings	17,134	3,333	20,467	.45
Lake	5,281	1,196	6,477	.14
Lassen	7,117	1,532	8,649	.19
Los Angeles	1,712,545	152,001	1,864,546	40.80
Madera	12,533	2,604	15,137	.34
Marin	30,747	3,171	33,918	.74
Mariposa	1,912	425	2,337	.05
Mendocino	14,355	3,378	17,733	.39
Merced	24,914	5,299	29,213	.64
Modoc	3,954	1,251	5,205	.11
Mono	611	183	794	.02
Monterey	46,104	7,526	53,630	1.18
Napa	16,546	2,583	19,129	.42
Nevada	9,421	1,368	10,789	.24
Orange	93,106	9,406	102,512	2.22
Placer	16,025	2,921	18,946	.41
Plumas	5,418	1,206	6,624	.14
Riverside	65,619	8,612	74,231	1.62
Sacramento	102,422	13,902	116,324	2.55
San Benito	5,642	1,418	7,060	.15
San Bernardino	103,680	12,084	115,764	2.54
San Diego	198,608	18,671	217,279	4.75
San Francisco	237,574	30,297	267,871	5.88
San Joaquin	74,194	13,834	88,028	1.93
San Luis Obispo	20,968	3,484	24,452	.54
San Mateo	90,700	7,137	97,837	2.14
Santa Barbara	40,970	5,658	46,628	1.02
Santa Clara	115,532	15,063	130,595	2.86
Santa Cruz	28,066	4,322	32,388	.71
Shasta	14,981	3,320	18,301	.40
Sierra	915	248	1,163	.03
Siskiyou	12,744	3,254	15,998	.35
Solano	36,657	3,908	40,565	.89
Sonoma	43,259	8,323	51,582	1.10
Stanislaus	50,076	8,315	58,381	1.28
Sutter	10,263	2,610	12,873	.28
Tehama	7,626	1,794	9,420	.21
Trinity	1,608	452	2,060	.05
Tulare	54,046	9,765	63,811	1.40
Tuolumne	5,539	1,176	6,715	.15
Ventura	41,930	5,602	47,532	1.04
Yolo	15,933	4,596	20,532	.45
Yuba	10,068	1,926	11,994	.26
Interstate	5,874	1,115	6,989	.15

Table 5. Number of automobile batteries manufactured.[1]

Year	Total production	Replacement batteries
1930	13,000,000	9,380,000
1940	18,000,000	14,342,000
1945	18,300,000	17,560,000
1948	29,000,000	23,725,000
1949	24,000,000	18,342,000
1950	31,000,000	23,128,000

[1] Data from United States Public Roads Administration.

omitted since they would not appreciably alter this figure, include copper, nickel, silver and certain paint products.

Replacement batteries are defined as batteries which are installed in used cars or equipment to replace the original battery or another replacement battery. Equipment batteries represent the batteries with which the new vehicle is equipped. Most of the replacement batteries in cars registered in California were made in California; some but not all of the equipment batteries sold in California were made in the state. In

Table 6. Estimated consumption of lead in storage batteries.

Year	Antimonial pig lead (short tons)	Lead content of oxides (short tons)	Total
1940	115,000	107,000	222,000
1945	158,700	136,300	295,000
1948			373,300

1948, approximately 2,210,000 replacement batteries and 490,000 equipment batteries were manufactured in or imported into California. A large number of batteries are exported to foreign countries and to neighboring states; because it is probable that these exports nearly balance

Table 7. Components of 3H-type battery parts.

Part and description	Number	Weight (in pounds)
3-cell battery box, rubber or composition	3	17.3
Cell caps	3	
Cell covers	3	
Separators	54	
Posts, antimonial lead 3 percent	6	2
Plate connecting straps, antimonial lead 3 percent	6	
Cell connecting straps, antimonial lead 3 percent	2	
Negative grids, antimonial lead 9 percent	30	12.8
Positive grids, antimonial lead 9 percent	27	
1 gallon dilute sulfuric acid, 1.280 specific gravity		12
Asphalt sealing compound		½
Oxides of lead		13
Total weight of hypothetical battery		57.6

the imports from other states, the total of 2,700,000 batteries (equipment batteries and replaced batteries) probably approximates California's 1948 production. Based on the average value of the export battery for 1948 (table 10) the total yearly value of the California battery production would be $31,600,000.

Table 8. Breakdown of 3H-type battery into raw material items.

Item	Weight (in pounds)
Box, covers, asphalt, caps	16.5
Separators	1.25
Sulfuric acid electrolyte (specific gravity 1.280)	12.00
Antimony	1.06
Lead oxides and metallic lead (as lead)	24.80
Total	55.61

THE BATTERY INDUSTRY

Classification

The American battery industry may be divided into three main groups: 1) the assemblers of batteries, 2) the suppliers to battery assemblers, 3) the merchandisers of the assembled batteries.

The battery assemblers constitute companies actively engaged in the manufacture of batteries. These may be small organizations which employ several men or nation-wide concerns with factories in all sections of the country.

Table 9. Value of materials in a 3H-type battery (1948).

Item	Value in dollars
Box, covers, asphalt, caps	1.60
Separators	.43
Sulfuric acid electrolyte	.30
Antimony	.39
Lead oxides and metal	5.23
Total	7.95

The suppliers are manufacturers of raw or semi-finished products such as lead oxides, antimonial lead, battery cases, separators and sulfuric acid.

Merchandisers constitute the outlet through which the batteries are distributed to the automobile-using public. These may be small dealers, such as independently owned service stations, or huge, nationally dispersed mail order houses.

The function of some concern may overlap into two or three of the above categories. For example one large mid-western corporation makes its own oxides and is thus a supplier; it is also a subsidiary of a motor car company which uses its batteries exclusively in all its new cars. Thus it is a battery supplier, manufacturer, and merchandiser and produces a large proportion of all new-car batteries in the United States.

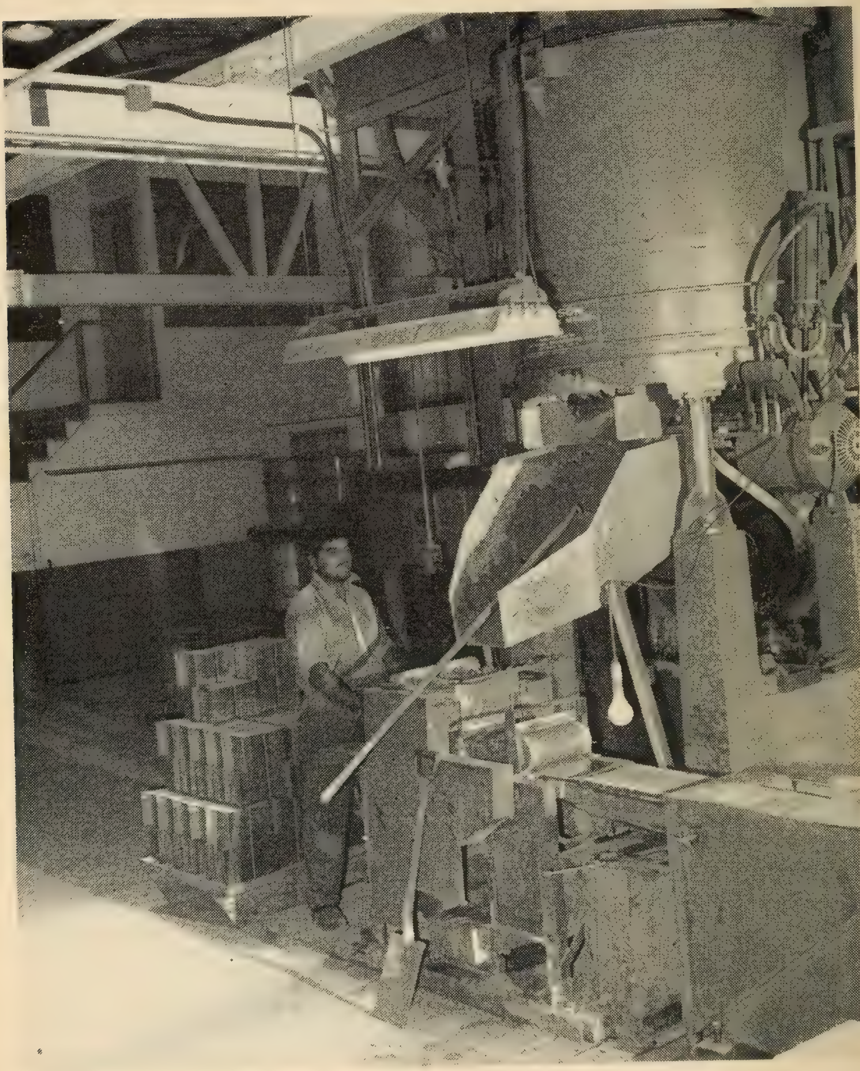


FIGURE 2. Modern grid pasting operation. The dry lead oxide powder is combined with dilute sulfuric acid in the mixer. The resulting paste is emptied into the hopper of a pasting machine where it is forced into the meshes of the cast lead-antimony grids. The freshly pasted plates are passed through a pair of rolls and carried by a belt conveyor through the drying oven in the right foreground. *Photo courtesy Hobbs Battery Company.*

Table 10. Value of exported batteries.

Year	Number of batteries exported (6- and 12-volt)	Value of batteries exported (6- and 12-volt) (in dollars)	Average value per battery (in dollars)	Average price of lead per pound (in cents)	Average price of antimony per pound (in cents)
1930	262,958	1,814,567	6.93	5.5	6.72*
1935	251,923	1,161,676	4.62	4.0	14.08
1940	250,048	2,120,580	4.72	5.1	14.00
1945	720,925	6,813,114	9.44	6.5	15.84
1948	621,408	7,283,010	11.71	18.04	36.66

* Figures available for 1931 only.

Trends in Manufacturing Methods

During the late 1920's and early 1930's some of the large established battery concerns began manufacturing a leady-type of oxide as a replacement material for the customary red lead and litharge used in positive and negative plates respectively. The use of this type of material probably resulted from the discovery by a Japanese industrialist, Genzu Shimadzu, that by revolving lead balls in a drum, a fine powder that makes an excellent active material for battery plates could be produced. Litigation that developed over the use of material made by processes similar to that of Shimadzu did not cease until the outbreak of World War II. The present trend appears to be away from oxide manufacture by the large battery makers, and back to oxide manufacture by the lead and lead pigment producers.

Table 11. Ratio of re-registered cars to replacement batteries purchased.[1]

Year	Re-registered cars: replacement batteries
1935	2.29 : 1
1940	1.92 : 1
1945	1.70 : 1
1948	1.49 : 1

[1] 1949 Yearbook. The Storage Battery industry.

Seasonal Trends

The demand for replacement batteries is remarkably seasonal. This can be demonstrated by a visit to the various manufacturing concerns or perhaps more accurately by reference to the Dun and Bradstreet monthly reports of shipments of automotive replacement batteries. In the late winter and early spring months of February, March and April, activities reach a low ebb. A visitor to a typical battery shop at this time will find few employees and will note a prevailing desultory attitude. In late spring and early summer, business picks up briskly and usually reaches a sharp peak in October. At this peak period it is almost impossible for the average battery manufacturing concern to keep up with

Table 12. Estimated weight of battery materials used in California, 1948.

Item	Replacement batteries	Equipment batteries
	(pounds)	(pounds)
Box, covers, caps, asphalt	36,400,000	8,090,000
Separators	2,760,000	612,000
Sulfuric acid (1.280 sp. gr.)	26,500,000	5,880,000
Antimony	2,340,000	519,000
Lead oxides and metal	54,800,000	12,150,000

the demand from the jobbers. Every available inch of space is at a premium for the various operations of pasting, drying and stacking of plates, and assembling.

Unfortunately, it does not seem advisable or practical for the manufacturer to assemble a large enough stock during the slack period to take care of the excess during periods of peak activity. The reason for this is threefold: first, batteries are bulky and a large stock made up and kept on hand for a period of six months or more would require a large warehouse; second, even though a large stock could be made up, batteries are somewhat perishable and in order to keep them at peak electrical capacity and prevent damage due to storage for extended periods, it is necessary to keep the batteries charged. Such a procedure is undesirable from an economic standpoint. Third, and probably the most important reason, is the fluctuating price of lead and antimony. To carry a large stock of batteries is to carry a large inventory of lead; a sudden drop in the market price of lead could be disastrous to one holding large stocks of processed lead materials. Such a drop occurred in the period March 1949 to March 1950, when the price of lead dropped from 21.5¢ to 10.5¢ per pound.

It appears likely that until some method is devised to eliminate the above difficulties, the major part of the lead-acid storage battery industry —the replacement battery industry—will remain subject to regularly occurring periods of slack and periods of activity. An illustration of this phenomenon, taken from the Dun and Bradstreet report for the years 1949-51, is shown in table 14.

Table 13. Value of battery materials.

Item	Value (in dollars)
Box, covers, caps, asphalt	4,324,000
Separators (wood)	1,163,000
Sulfuric acid	812,000
Antimony	1,054,000
Lead oxides and metal	14,280,000
Total	21,633,000

Table 14. Shipments of United States automotive replacement batteries. Monthly indices: 1934-1936 = 100%; 100% = 865,000 batteries.

Month	Percent of 1934-1936 index		
	1949	1950	1951
January	144	169	216
February	95	136	161
March	65	138	128
April	58	106	----
May	79	138	---
June	122	190	---
July	189	238	.
August	306	328	---
September	322	338	--
October	297	347	---
November	246	293	.
December	196	251	---
Average	177	223	.

Association of American Battery Manufacturers

Any discussion on the lead storage battery industry would not be complete without a mention of the Association of American Battery Manufacturers. The A.A.B.M., as it is called, was organized in 1925 and now includes most of the large-, medium- and small-sized battery companies as active members. In addition to active company memberships, it also includes suppliers and merchandisers in a category designated as associated members. One of the prime purposes of the A.A.B.M. is to collect statistics from its members in order to determine contemporary trends in the battery industry; many of these statistics have been useful in preparing the present paper. In recent years the A.A.B.M. has indicated the importance it attaches to the California battery industry by holding two of its semi-annual national conventions in Los Angeles (1947) and San Francisco (1951). A study of the complete membership list shows that the California membership outnumbers all others. Although most of the large national battery manufacturers have headquarters located in the east or mid-west, many maintain important factories in California.

Without resort to additional statistics, it can be assumed that California is not only the largest consumer but also the largest producer of replacement batteries and processed materials which go into such batteries.

Table 15. Raw materials of mineral origin used by the battery industry.

Lead	Copper	Magnesium salts
Litharge	Nickel	Tellurium
Red lead	Silica	Silver
Leady oxides	Antimony	Calcium
Barytes	Carbon black	Asphalt
Blanc Fixe	Sodium salts	Aluminum
Sulfur	Ammonium salts	Synthetic rubber
Diatomaceous earth		Talc

MATERIALS USED BY THE BATTERY INDUSTRY

It is impossible to obtain reliable statistics on many of the minor ingredients incorporated into batteries such as barytes, diatomaceous earth and carbon black, because the use of such materials is frequently kept as a manufacturing secret.

The component battery parts which are processed from the above list of raw materials can be classified in five distinct groups: 1) container, including covers, caps, paint coating and sealing compound; 2) electrolyte; 3) separators; 4) grids, connecting straps and posts; 5) active oxides which are pasted into the grids.

The container box is, for 6-volt batteries, a case divided into three compartments; 12-volt batteries require larger boxes having six compartments. Boxes are made of hard rubber and molded asphalt (composition) with fillers of talc and silica. Plastics and cotton fibers are also incorporated into the asphalt composition.

Hard rubber cases are generally considered the most serviceable. During the World War II, when rubber was unobtainable, composition cases were substituted, and are now being used in smaller and cheaper batteries. Battery life was shortened by case failures which occurred as a result of cracking and gradual seepage of the acid into the fibers of the partitions. Many improvements have been made in creating more impervious linings by the incorporation of plastics.

Aircraft batteries are sometimes fitted into aluminum outer cases. These aluminum cases are coated inside and out with special plastics to resist corrosive action of sulfuric acid.

Typical examples of materials used in cases are:

Composition

Asphalt	45%
Resin	4%
Mineral matter, pyrophyllite, talc	40%
Fiber-cotton linters	11%
	100%

Hard Rubber

Synthetic and natural rubber	40%
Sulfur	7%
Talc, etc.	53%
	100%

Most of the cases used in California are manufactured in the Los Angeles area from minerals obtained in the state.

Dilute sulfuric acid is used as an electrolyte to carry current between the porous surfaces of the positive and negative plates. It is necessary that the acid be free from all metallic impurities which tend to cause self-discharge of the active plate materials.

The customary battery acid or electrolyte is diluted with water to a specific gravity of about 1.280, or a concentration of 36.8% acid by weight. The average-sized battery contains about 4 pounds of concentrated sulfuric acid that has been diluted to the above specific gravity.

Because additional acid is necessary in forming the plates electrically, it can be calculated that the average battery requires over 5 pounds of concentrated acid in its production and use. About $1\frac{2}{3}$ pounds of sulfur are required to produce the sulfuric acid.

Separators used between the positive and negative plates are usually made of wood, although porous rubber, diatomaceous earth and glass are also used separately or in combination. Port Orford cedar is preferred when available, but many other types of wood are also used, such as Oregon fir, cypress and redwood. The separators are prepared by cutting grooves on one side and leaving a series of narrow ribs, between which is a thin portion called the web. The purpose of the separator is to prevent contact of the positive and negative plates and also to prevent any growth of lead salts between the two sets of plates. The separators must prevent actual physical contact between plates, but must be sufficiently porous to allow free passage of electrolyte between plates. In addition, the separators must be able to withstand the chemical action of dilute sulfuric acid.

The newly developed microporous rubber separators are, for a number of reasons, the most satisfactory in actual use but are still too expensive to compete successfully with wooden separators. However, for certain special purposes, such as in dry-charged batteries, it is necessary to use microporous rubber separators. They are therefore extensively used in commercial battery production in spite of their relatively high cost.

The grids and connecting straps are made of antimonial lead, the straps and grid posts being usually a 3 percent antimonial-lead alloy. The grid usually contains 9-12 percent of alloyed antimony. Recent work has been done with other metals such as silver, tellurium, calcium and aluminum in the grid frame. The use of such materials is experimental and the subject is surrounded with much secrecy.

Antimony is added to the grid for several reasons: 1) it gives a clean casting with more accurate and reproducible results than can be obtained with soft lead; 2) it resists sulfuric acid better; and 3) it is harder than soft lead and less subject to mechanical damage.

The active ingredients pasted into the grid electrodes consist of finely divided lead oxides or metallic lead powders or combinations of both. The materials used are red lead, litharge, and leady-litharge.

Prior to 1930 most oxide demands were filled with low percentage red lead in the positive plate and litharge in the negative plate. In recent years the trend has been toward leady oxides in both positive and nega-

Table 16. Lead used in the manufacture of storage batteries.[1]

Year	Total lead[2] (tons)	Red lead[3] (tons)	Litharge[4] (tons)	Lead oxide[5] (tons)
1941	245,000	27,405	49,847	61,000
1942	216,000	23,545	43,630	55,000
1943	257,000	26,616	54,984	60,000
1944	307,000	30,211	72,342	61,000
1945	295,000	26,725	79,981	56,000
1946	260,000	19,115	75,836	46,000
1947	380,000	20,883	111,840	69,000
1948	373,000	14,854	100,645	69,000

[1] Data from American Bureau of Metal Statistics.
[2] Total lead includes the alloys of antimonial lead of primary and secondary sources used in construction of grids, posts and connecting bars together with the active oxides of the pasted plates.
[3] Red lead is any form of battery red lead (or litharge) which may vary from 15 percent red lead (Pb_3O_4) to 80 percent, the remaining portion being litharge or lead monoxide. This type of oxide is nearly always purchased by the battery manufacturers.
[4] Litharge is material including pure litharge and a leady-grade of partially oxidized litharge.
[5] Lead oxide is a grade of partially oxidized litharge sometimes referred to as lead suboxide or black oxide.

tive plates. A minority of manufacturers continue to use red lead and litharge. A few manufacturers use combinations of red lead, litharge and leady oxides.

The positive paste is made by adding sulfuric acid to litharge, red lead or leady oxide; the paste will harden, forming a porous cement in the grid.

Table 17. United States mine production of lead.

	Average tons per year 1938-1947		Percent of United States total	
Eastern States:				
New York, Virginia, Tennessee	5,485		1.32	
		5,485		1.32
Central States:				
S.E. Missouri	160,451		38.66	
Tri-State (Kansas, Oklahoma, Missouri)	33,102		7.98	
Arkansas, Illinois, Kentucky, Wisconsin	3,438		.83	
		196,991		47.47
Western States:				
Idaho	89,909		21.66	
Utah	53,690		12.94	
Arizona	17,087		4.12	
Montana	15,698		3.78	
Colorado	14,551		3.50	
California, Nevada, New Mexico, Washington	21,618	212,553	5.21	51.21
		415,029		100.00

The negative paste likewise contains leady oxides and sulfuric acid to which have been added one or more of many available expanding agents. Usually the total amount of expanding agent accounts for about 1 percent of the dry weight of the negative powder. The purpose of the expanding agent is to prevent the coalescing of the negative lead particles into a solid sheet of lead upon electrical charging. By maintaining porosity in the negative plate, it is possible for the electrolyte to reach more effectively a larger surface of metallic lead and release a larger proportion of the electrical energy contained in the negative plate.

The positive plate does not require expanding agents because it has a natural tendency to remain porous due to the normal porosity and expansion of the lead oxides which form lead peroxide upon charging. The subject of expanding agents forms a field for extensive experimentation by the oxide manufacturers. The chief agents used are barium sulfate, usually in the form of blanc fixe, and carbon black. Hundreds of natural and synthetic organic and inorganic chemicals have been employed in conjunction with the above basic expanders.[3]

Raw Materials

Lead

The most important raw material contained in batteries is lead. Table 17 shows the geographical distribution of mine production of lead in the United States and table 18 lists the world production for the same

[3] Ritchie, E. J., Electrochemical Soc., Trans., vol. 92, pp. 229-257, 1947.

Table 18. Lead production of the world.

Country	Tons produced		Percent of world total	
United States of America (domestic ore)	415,029		23.88	
United States of America (foreign ore)	69,942		4.02	
Canada	194,250		11.17	
Mexico	210,957		12.14	
Total—North America		890,178		51.21
Argentina	20,436		1.17	
Peru	37,860		2.18	
Total—South America		58,296		3.35
Australia		229,869		13.22
Austria (1945-1947)	3,400		.20	
Belgium (1946-1947)	36,000		2.07	
France (1938-1939, 1946-1947)	43,000		2.47	
Germany (1938-1944)	187,895		10.80	
Great Britain (1943-1947)	3,965		.23	
Italy (1947)	19,620		1.13	
Poland (1947)	12,490		.72	
Rumania (1945-1947)	3,705		.22	
Russia (1939)	82,500		4.74	
Spain (1938-1947)	33,485		1.93	
Sweden (1944-1947)	11,130		.64	
Yugoslavia	unknown		--	
Burma (1938-1941)	86,855		5.00	
Japan (1938-1941)	9,225		.53	
Korea	unknown		--	
Total—Europe and Asia		533,270		30.68
Africa, (1938-1940, 1947) (Rhodesia and Tunis)		27,300		1.57
Total world production		1,738,913		100.00

period. Table 17 is mine production of lead, whereas table 18 includes lead from all sources. Table 19 indicates the distribution of the use of lead for 1947. The present national consumption of lead is about 1,100,-000 tons per year. Although 450,000 tons is produced from primary

Table 19. Use of lead in the United States in 1947, including antimonial lead.

Use	Tons used	Percent of total
Storage batteries	367,400	32.03
Cable sheathing	155,100	13.52
Construction	112,500	9.81
Paint and varnish	91,600	7.99
Ammunition	39,900	3.48
Tetraethyl	84,600	7.38
Insecticides	32,700	2.85
Printing	25,600	2.23
Railroads (bearings)	22,700	1.98
Collapsible tubes	11,100	.97
Unclassified	203,800	17.76
	1,147,000	100.00

sources and 450,000 tons from secondary sources, the total production is about 200,000 tons short of requirements.

Table 20. Location of principal lead mining areas and major smelters in the world.

Country	Number of mining areas	Number of smelters	Country	Number of mining areas	Number of smelters
United States	6	8	Sweden	1	1
Canada	2	1	Germany	1	1
Mexico	1	1	Austria	1	1
Peru	1	1	France	1	1
Argentina	1	1	Spain	1	1
Brazil	1	1	Italy	1	1
Bolivia	1	--	Morocco	1	1
Australia	1	1	Algeria	1	1
Japan	1	1	Rhodesia	1	1
Korea	1	1	Burma	1	1
Russia	1	1			

During the ten year period 1937-47, production of secondary lead from scrap averaged 340,843 tons per year. This average figure, however, is not indicative of the potential volume. In 1947 production reached the all time maximum of 504,000 tons. The greatest single source of secondary or scrap lead is lead battery plates that have been salvaged from worn-out storage batteries. Since January 1, 1944, about 76 percent of all the lead consumed in the storage battery industry was returned for re-use. Secondary lead has now become equal to primary lead in volume production.

Grades of Battery Lead. The three grades of lead customarily used to produce active battery oxides in California are: common, containing .15 percent bismuth; corroding, containing .05 percent bismuth; and low bismuth, containing .015 percent bismuth. The corroding and low bismuth grades command a premium of .10 and .125 cent per pound over the common grade. The results of some experiments now being conducted to determine the effect of small amounts of bismuth in the oxides upon the practical performance of commercial batteries [4] may have a bearing on the selection of grades of lead for battery oxide purposes.

As the largest user of automotive vehicles, the State of California automatically becomes the largest source for scrap lead in the form of junk batteries. Two large smelters and refineries operating in the Los Angeles area recover lead containing about 5 percent antimony from junk batteries and other secondary sources. The antimonial content is adjusted in the refining process, and sold to the battery manufacturers for the production of grids, posts, and connecting straps. Some of the secondary lead is refined further and used in the production of battery oxides, although most battery oxides are produced from virgin lead.

California's largest smelter and refinery is located at Selby, Contra Costa County. All of the soft pig lead produced here is from ore, but some antimonial lead is produced from secondary sources. About 0.4

[4] Blair, T. B., and Haskell, D. H., The effect of pig lead composition on the life and capacity of lead storage batteries: Battery Symposium, 98th meeting of the Electrochemical Society, Buffalo, N. Y., October 13, 1951.

FIGURE 3. Plate assembling. The dried plates are assembled in racks and burned into contact by gas-oxygen flames. *Photo courtesy Hobbs Battery Company.*

percent of the ore smelted at Selby is obtained from California mining operations. Since 1942 the annual lead output of the state has ranged from 10 to 20 million pounds, and has averaged about 2 percent of the national output.[5] As shown in table 13, this output could account for 15-23 percent of the total yearly lead requirements for batteries used in the state.

Inyo County has been the principal lead-producing county in California; mines in the county produced nearly nine-tenths of the state's total production of lead in 1948. The production of one Inyo County mine has recently been used exclusively in the manufacture of battery grids.

However, according to Stewart,[6] "Most of the California lead ores and concentrate are shipped out of the state, rather than to the smelter at Selby, Contra Costa County. . . . The Selby smelter, however, provides California consumers with refined lead in quantity derived largely from imported ores."

Antimony

"Though antimony occurs at numerous localities in California, and was mined as early as 1887, only a few hundred tons of the metal have been obtained from mines within the state."[7]

The largest mine reserves of antimony in the United States are in the Yellow Pine district of Idaho. Prior to World War II most antimony used in the United States was obtained from China.

The potential junk batteries carried in the 4,000,000 plus cars of California offer a reserve of over 2,000 tons of antimony metal, a large part of which eventually finds its way back into fresh cells after its recovery from depleted batteries.

Lead ores imported into the state and smelted at the Selby plant are said to average about 2 percent-3 percent antimony content.

Asphalt

According to information obtained from various battery manufacturers, it has been estimated that somewhat more than one-half of all battery cases are of asphalt composition type. Based on this estimate and the estimates in tables 11 and 13, the yearly consumption of asphalt for the California battery industry is 8,750,000 pounds.

The heavy products of the petroleum industries of Santa Maria and Long Beach are used in the production of asphalt for composition type battery cases in the Los Angeles manufacturing plants. Natural asphalt is not used by the battery industry.

Sulfur

Elemental sulfur, obtained largely from Gulf Coast deposits, is combined with rubber during the vulcanization process in manufacturing the rubber case.

Sulfuric acid, the active ingredient of the electrolyte, is made in several plants in the San Francisco Bay area and the Los Angeles area. In one process, elemental sulfur is burned to SO_2 and subsequently converted

---

[5] Stewart, R. M., Lead in Mineral Commodities of California: California Div. Mines Bull. 156, p. 319, 1950.
[6] Stewart, R. M., op. cit., p. 323.
[7] Norman, L. A., Jr., Antimony in Mineral Commodities of California: California Div. Mines Bull. 156, pp. 288-291, 1950.

into sulfuric acid. Although small amounts of elemental sulfur have been intermittently produced, principally from deposits in Inyo County, much of the sulfur used in the production of sulfuric acid does not appear in the statistics as elemental sulfur. Such sources include pyrite ($Fe\ S_2$) mined in Shasta County, hydrogen sulfide gas evolved in the refining process at various oil refineries in the San Francisco Bay and Los Angeles areas, and sulfuric acid recovered as a by-product from operations at the Selby smelter.

Talc

The "talc" used in the battery industry consists in the main of two general types: 1) steatite ($H_2Mg_3(SiO_3)_4$), an unusually pure form of talc, and 2) pyrophyllite ($Al_2Si_4O_{10}(OH)_2$). Steatite[8] is obtained largely from the Inyo Range in Inyo County; pyrophyllite is now being commercially produced in Mono, Inyo and San Diego Counties. Most of the "talc" for battery boxes is obtained from California sources.

Rubber

In 1951 less than half of all battery cases were made of hard rubber. The rubber content of a case consists of re-worked rubber to which a certain proportion of new natural or synthetic rubber, obtained from butadiene and styrene, organic chemicals derived from products of the California petroleum industry, is added. Rubber requirements for the so-called "genuine hard rubber" box is presently supplied almost entirely from synthetic stock, which, together with talc and sulfur, makes the case 100 percent mineral in composition.

Silica

Fiber glass matts are inserted between the faces of the positive plates and the regular wood or rubber separators in some batteries. This practice is referred to as double insulation. The glass matts are customarily treated with resinous acid-resistant bonding agent which increases their durability in handling.

Barium Sulfate

Barytes or barite refers to naturally occurring barium sulfate ($BaSO_4$), and blanc fixe to artifically precipitated barium sulfate. Although barite ($BaSO_4$) has been obtained in California largely from a deposit near El Portal, Mariposa County, only blanc fixe, derived chiefly from Nevada deposits, is used in the battery industry.

Calcium

A fraction of a percent of calcium is used in the grids of telephone batteries. Most of such batteries are made in New York and Pennsylvania and other eastern battery manufacturing centers. The use of calcium as a partial substitute for antimony in automotive types of lead grids has not proved satisfactory in experiments to date.[9]

Tellurium

Tellurium, like calcium, has been considered as a substitute for antimony in lead grids. Work on the use of this metal for such a purpose has been kept secret. No specific commercial application of tellurium is known by the writer.

[8] Wright, L. A., Talc in Mineral Commodities of California: California Div. Mines Bull. 156, pp. 276-282, 1950.

[9] Willihnganz, E., American Association of Battery Manufacturers, Minutes, Spring Meeting (April 1951) San Francisco, California.

Silver

Silver has been recommended as a possible alloying metal to replace antimony in part in lead-antimony grids and is especially recommended for use in the positive grid to inhibit corrosion and lengthen battery life. Although it is known that silver is being used by the battery industry in California, the subject is shrouded in some secrecy, and estimates of the amount so consumed in California are not readily obtainable.

Most of the silver recently mined in California was derived from the lead and zinc ores of Inyo County. Some of the silver mined in this region finds its way directly into the lead antimony grids of batteries without separation from the lead.

Copper

Copper is used as a core for the lead connecting straps in some large truck and diesel-type batteries. Because these batteries must deliver a thousand or more amperes of electrical current, it is necessary to use an alloy with a lower resistance than the lead-antimony alloy usually used for straps. Copper is superior to lead, for this purpose, as lead is a relatively poor electrical conductor.

The amount of copper so used is small and probably does not account for more than several thousand pounds per year in California. Although a large amount of copper is used in battery shops for such purposes as bus bars, knife switches, electrical wiring, motors, generators, rectifiers and other equipment necessary to charge and discharge batteries, such use of copper has not been included in the present consideration of the battery industry because it applies more properly to the electrical industry. The content of copper in lead batteries is negligible or nonexistent but the use of copper in the production and operation of batteries is important.

Most of California's copper production (1946) comes from Shasta, Plumas and Calaveras Counties.

Nickel

A minute amount of nickel salts is used in the electrolyte or the negative battery plate in some batteries to modify voltage characteristics. Neither the amount or the use of the salts is of much importance and its utilization is the subject of some technical controversy within the battery industry.

Other Raw Materials

Carbon black, cotton fiber filler, wood and ligneous products constitute the balance of materials produced in California and used in the battery industry.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to the following persons and companies for their assistance and cooperation in assembling some of the data used in this article: H. P. Wagner, American Smelting and Refining Company, Selby; J. J. Giusti, Hobbs Battery Company, Oakland; K. M. Ebert, Laher Spring and Tire Corporation, Oakland; F. W. Reiter, Pacific Hard Rubber Company, Los Angeles; K. W. Green, The Electric Storage Battery Company, Philadelphia, Pennsylvania; George Lippincott, Sun Battery Company, Santa Ana; N. F. Helper, States Batteries, Ltd., San Francisco. The author is indebted to W. P. Fuller and Company for permission to publish the article.

MINES AND MINERAL RESOURCES OF GLENN COUNTY, CALIFORNIA

By J. C. O'Brien * and L. T. Braun **

OUTLINE OF REPORT

Illustrations

ABSTRACT

Glenn County, created March 11, 1891 from the northern part of Colusa County, includes 842,880 acres of land about one-third of which is in the Sacramento Valley at altitudes as low as 65 feet. Agriculture is the principal industry. Except for natural gas and some manganese and chrome ores mined during war years, the mineral production consists almost entirely of sand and gravel. Chromite occurs banded and disseminated in the narrow belt of serpentine that trends northwestward along the eastern slope of the Coast Ranges. Narrow stringers bearing gold, silver, and copper occur in the Franciscan formation northwest of Elk Creek. Manganese oxides and silicates occur in chert beds in the Franciscan formation in the southwestern part of the county. Natural gas occurs in Cretaceous beds at several localities. Exploitation of the extensive deposits of sand and gravel in many areas in the Sacramento Valley is the principal mineral activity.

* District Mining Engineer, California Division of Mines.
** Assistant Mining Geologist, California Division of Mines. Manuscript submitted for publication July, 1951.

INTRODUCTION

History

Glenn County was named for Dr. Hugh J. Glenn who came to California with the '49ers. He mined gold along the American River for a few years and in 1853, settled in an area that is now within the borders of Glenn County. He acquired some 55,000 acres of land and having planted 41,000 in wheat, became known as the "Wheat King." [1]

Geography

Glenn County, created March 11, 1891 from the northern part of Colusa County, extends westward from the Sacramento River and Butte County to Mendocino and Lake Counties in the Coast Range. Tehama County borders it on the north. Of the 842,880 acres of land within its borders, 75 percent or 630,409 acres are privately owned. The remainder is publicly owned including 183,930 acres of the Mendocino National Forest. Elevations vary from a low of 65 feet in the Sacramento Valley to a maximum of 7,450 feet in the Coast Ranges in the western part of the county. The foothill area in the central portion includes many fertile valleys. The weather is warm and dry in the summer with an average temperature of 79 degrees in July. The winters are wet with an average rainfall of 17 inches from October to March; some snow falls in the mountains. The temperature averages 44 degrees in January.

Transportation

The mainline of the Southern Pacific crosses the county from north to south in the eastern section and a branch line connects the central section at Willows. U. S. Highway 99W follows the railroad and 860 miles of branch roads provide good motor transport facilities.

Population

Glenn County had a population of 15,341 according to the 1950 census, an increase of 3,146 over the 1940 count. Willows, the county seat and the largest city, has an estimated population of 2,250. It is the center of livestock, dairy, poultry, and field crop production. Orland, with a population of 1,366 is a trading center for alfalfa, nuts and fruits. It also has a large butter processing plant.

Industries

Agriculture is the principal industry in Glenn County and the value of the products amounted to $19,047,000 in 1944. Field crops contributed most, tree crops were second and livestock products were third. Rice, butterfat, sheep, lambs, and wool, barley, hogs, almonds, fat cattle, and hay were the leading items in the order named. There were 1,376 farms in 1940 and more than 40 percent of the 227,517 acres of crop land is irrigated. Food processing plants include one of the largest cheese factories in the United States, an olive cannery and citrus fruits and prune processing plants. The mineral production in 1949 included natural gas, sand and gravel.

---

[1] Beauchamp, M., and Perry, R., California Almanac and State Fact Book, 1948-1949; Bell, California, California Almanac Company, p. 485, 1947.

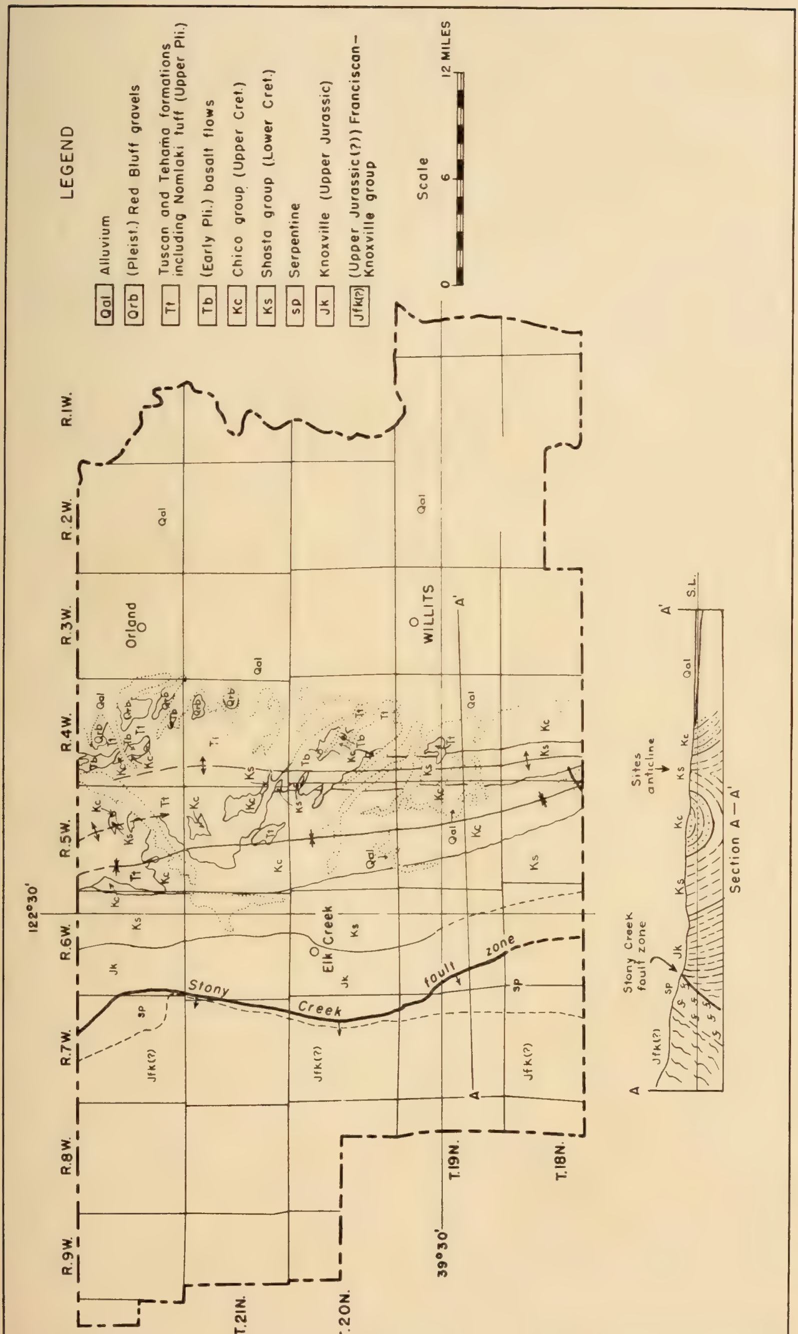


FIGURE 1. Geologic map of Glenn County and structure section across Sites anticline.

GEOLOGY[2]

Glenn County may be divided into two distinct geologic units, the boundaries of which coincide with similarly named and widely known geographic units. These are the Coast Ranges, a folded and faulted mountain chain which strikes in a northerly direction through the western half of the county, and the Sacramento Valley, an alluviated geosyncline occupying the eastern half of the county. The accompanying geologic map and cross-section (figure 1) illustrate the general structure and stratigraphy of the area.

Unfortunately, much of the high mountain area has not been examined in detail, and knowledge of its geology is incomplete. Deep wells and geophysical surveys have contributed to knowledge of the formations under the valley alluvium,[3] and have revealed an extremely deep asymmetrical geosyncline. The axis of this geosyncline runs along the western side of the valley where approximately 50,000 feet of Upper and Lower Cretaceous marine sediments lie under a mantle of valley alluvium. To the west of the axis these Cretaceous beds are folded into the Sites Anticline and fault-terminated against older metasediments. To the east the Lower Cretaceous sediments wedge out and are overlapped by the Upper Cretaceous formations which in turn wedge out and lap on the Sierran granite batholith.

Franciscan-Knoxville Group. Under this designation is included a thick series of Upper Jurassic marine rocks that are predominantly clastic in origin. They consist of arkosic sandstones, some conglomerates, black clay shales and silts, with the finer sediments predominating toward the top of the group. Included in the series are red and green radiolarian cherts, basalts and a few limestone beds. During the latter part of this depositional period large bodies of ultrabasic and basic rocks, now largely serpentinized, were intruded into the sediments.

In Glenn County, as in many other places, the Franciscan-Knoxville contact is obscured by a serpentine intrusion. The Franciscan rocks in the extreme southern mountain area of the county consist principally of gray-green arkosic sandstone, red and green chert lenses, conglomerate, and serpentine intrusions. The overlying belt of Knoxville rocks extends in a north-south direction throughout the entire county, separated from the older (?) metasediments by a serpentine belt of varying width. The Knoxville rocks are principally black clay shales with thin sandstone beds and some limestone beds. Toward the base of the Knoxville there is a prominent ridge-forming pebble conglomerate zone consisting principally of red and green chert pebbles that were undoubtedly derived from the older Franciscan rocks.

In the western part of Glenn County, high in the Coast Range west of the serpentine body, are found exposures of sediments and metasediments whose exact age is somewhat uncertain. In addition to common Franciscan and Knoxville types are gray slaty sericite schists, and phyllites containing numerous stringers of white quartz. Mild regional metamorphism in this area has not wholly destroyed fossils that suggest Upper

[2] By Lewis T. Braun, Assistant Mining Geologist, California Division of Mines.
[3] Hobson, H. D., Possible future petroleum provinces of North America, Sacramento Valley: Am. Assoc. Petroleum Geologists Bull., vol. 35, no. 2, pp. 209-214, 1951.

CONCRETE BATCHING PLANT
Wruck Brothers and Davis plant at Willows

LOADING SAND AND GRAVEL
At Lester G. Madsen pit northeast of Willows.

A, ELK CREEK QUADRANGLE
View east from western Glenn County. Ks—Shasta series rock; Jk—Knoxville formation; Sp—serpentine; Jfk—Franciscan-Knoxville rocks.

B, ST. JOHN MOUNTAIN
South from Felkner Ridge, T. 18-19 N., R. 7 W.

GRAVELLY RIDGE
Elk Creek Quadrangle

Jurassic age. In the absence of detailed geologic mapping it appears most likely that the rocks of western Glenn County are in that part of the Franciscan-Knoxville group below the upper Knoxville formation.

The total thickness of the Franciscan-Knoxville group is unknown, although F. M. Anderson [4] has assigned a thickness of 14,000 feet to the Knoxville at Elder Creek in adjacent Tehama County.

Shasta Group. Unconformably overlying the Knoxville series are marine shales and siltstones and thin sandstones and dense limestones of Lower Cretaceous age. According to Kirby [5] 5,000 feet of the Horsetown formation of uppermost Lower Cretaceous age is exposed along the axis of the Sites anticline.

Chico Group. Overlying the Lower Cretaceous beds, probably unconformably, is the Chico group which includes all the sediments of Upper Cretaceous age. Lithologically these sediments are similar to the Shasta group, but contain a much higher percentage of coarser clastics. Certain dominant sandstone zones in the group have been given formation names. Approximately 10,000 feet of Chico marine sediments have been measured along the axis of the Sites anticline.[6]

Tehama Formation. The Tehama formation is an accumulation of poorly sorted, cross-bedded silts, silty clays, and sands and gravels that were deposited under flood plain conditions in the northern Sacramento Valley in upper Pliocene time. The distribution, composition, and attitudes of these sediments indicate that they were derived from the Coast Ranges and accumulated on the western side of a broad valley, similar to the present Sacramento Valley, but of greater extent.[7] A prominent tuff member, the Nomlaki tuff, occurs near the base of the Tehama formation, and is an excellent marker bed through the region. The Tehama formation attains a thickness of approximately 2000 feet in the center of the valley, and thins to a wedge edge as it laps up on the Upper Cretaceous sediments. At some localities in Glenn and Tehama Counties a 10-foot thick layer of basalt has been found between the Upper Cretaceous sediments and the overlying Tehama formation.

Tuscan Formation. The Tuscan formation does not crop out in Glenn County, but it is present beneath the valley alluvium. The formation consists of a series of volcanic breccias, tuffs, volcanic gravels and sands, and tuffaceous clays. The source of these sediments was probably old volcanoes in the Cascade Range. The Tuscan formation is distributed along the eastern side of the northern Sacramento Valley and ranges in thickness from a few feet on the eastern edge of the valley to approximately 1,000 feet in the center of the valley. The Tuscan formation was deposited contemporaneously with the Tehama formation, and the two interfinger in the center of the valley. The Nomlaki tuff is continuous from one formation into the other, and crops out on both sides of the valley.

Red Bluff Formation. The Red Bluff formation is a Quaternary (probably Pleistocene) alluvial formation consisting of gravel and inter-

[4] Anderson, F. M., Chico series in California and Oregon: Geol. Soc. America Bull., vol. 49, no. 12, pt. 2, p. 1863, 1938.
[5] Kirby, J. M., Sites Region: California Div. Mines Bull. 118, p. 606, 1943.
[6] Kirby, J. M., op. cit.
[7] Anderson, C. A., and Russell, D. R., Tertiary formations of northern Sacramento Valley, California: California Div. Mines Rept. 35, pp. 219-253, 1939.

bedded sands. It is characterized by a brick red color which helps to distinguish it from the underlying Tehama formation. The average thickness of the formation in Glenn County is about 50 feet, although it may be more in channels.

Summary of Economic Geology

Chromite. Commercial deposits of chromite always originate in intrusive masses of ultrabasic rock. In California these chrome-bearing ultrabasic masses are always either partly or completely altered to green serpentine rocks. Concentrations of chromite in this rock are found as drawn-out tabular lenses and as kidneys or pods. The origin of these concentrations has been explained both as being an original constituent of the rock and as a later hydrothermal feature concentrated along shear planes.[8] The chrome-bearing ultrabasic body in T. 22 N., R. 7 W. has been studied in detail [9] and found to consist of four distinct types of partly serpentinized ultrabasic rocks. Rynearson and Wells found the chromite to be an original constituent of dunite, a variety of ultrabasic rock composed almost entirely of olivine.

Manganese. Deposits of manganese are found in many places throughout the Coast Ranges of California [10] and are almost always associated with the red and green cherts found in the Franciscan formation. The manganese minerals were originally deposited as light-colored lenses of manganese carbonates and silicates interbedded with chert. Where these manganiferous zones have been exposed to weathering agents they have been converted to black manganese oxides. Because the Franciscan cherts in Glenn County are confined to the southwestern part of the county, that is where deposits of manganese have been found. Chert beds are sometimes found in the Knoxville formation, but they are not common. A rather unusual occurrence of sub-commercial amounts of manganese has been reported [11] in cherty zones in the metasediments of Glenn County.

Natural Gas. Commercial accumulations of natural gas are almost always found in porous zones in marine sediments, or in porous rocks in the proximity of marine sediments. Therefore, the sandy Chico formation is the most logical zone in which to expect to find natural gas in Glenn County, and all of the natural gas produced in Glenn County has come from this formation. However, there is a possibility that the sandy basal phases of the continental Tehama formation might provide suitable reservoir rocks, as they have in adjacent Tehama County.

Sand, Gravel, and Rock. Sand, gravel, and rock are always in demand for construction purposes, and Glenn County has an adequate supply of most types of this material. The Quaternary stream gravels provide satisfactory material for concrete aggregate and road bed material. The Nomlaki Tuff has been quarried for dressed stone, and doubtless certain zones in the Chico formation could be quarried for dressed stone if a market existed.

[8] Allen, J. E., Geological investigations of the chromite deposits of California: California Div. Mines Rept. 37, pp. 101-164, 1941.
[9] Rynearson, G. A., and Wells, F. G., Geology of the Grey Eagle and some nearby chromite deposits in Glenn County, California: U. S. Geol. Survey Bull. 945-A, 1944.
[10] Manganese in California: California Div. Mines Bull. 125, 1943.
Trask, P. D., et al., Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, 1950.
[11] Trask, P. D., et al., op. cit., pp. 58, 62.

Table 1. Mineral production of Glenn County, 1893-1949.

Year	Amount	Value	Substance
1893 and previous	3,319 tons	$49,700	Chromite
1909	140,000 tons	49,000	Macadam
1910	378,000 tons	34,020	Rubble
1911	421,775 tons	51,430	Sand and gravel
1912	543,675 tons	32,950	Sand and gravel
1913	416,640 tons	27,776	Sand and gravel
1914		30,553	Miscellaneous stone
	746 lbs.	131	Copper
1915		46,526	Miscellaneous stone
		10	Other minerals
1916		41,180	Miscellaneous stone
		39,982	Other minerals
1917	879 tons	21,474	Chromite
	369 tons	9,721	Manganese
		33,260	Miscellaneous stone
		817	Other minerals
1918	1,129 tons	57,263	Chromite
		32,436	Miscellaneous stone
1919		58,137	Miscellaneous stone
		1,500	Other minerals
1920		134,707	Miscellaneous stone
1921		103,197	Miscellaneous stone
1922		91,250	Miscellaneous stone
1923		113,282	Miscellaneous stone
1924		41,550	Miscellaneous stone
1925		92,288	Miscellaneous stone
1926		58,391	Miscellaneous stone
1927		63,869	Miscellaneous stone
1928		101,889	Miscellaneous stone
1929		81,516	Miscellaneous stone
1930		61,179	Miscellaneous stone
1931		47,462	Miscellaneous stone
1932		8,714	Miscellaneous stone
1933		11,690	Miscellaneous stone
1934		30,608	Miscellaneous stone
1935		2	Gold
		41,285	Miscellaneous stone
1936		134,466	Miscellaneous stone
1937		136,368	Miscellaneous stone
1938		60,138	Miscellaneous stone
1939		54,519	Miscellaneous stone
1940		16,891	Miscellaneous stone
1941		33,204	Miscellaneous stone
1942		504,755	Unapportioned
1943		915,030	Miscellaneous stone, other minerals
1944		33,736	Miscellaneous stone, chromite, natural gas, manganese ore
1945		72,046	Miscellaneous stone, natural gas, other minerals
1946		141,508	Miscellaneous stone, natural gas, other minerals
1947		*388,043	Miscellaneous stone, natural gas
1948		*271,276	Miscellaneous stone, natural gas
1949		*336,008	Miscellaneous stone, natural gas
Total		$4,866,918	

* Combined with Tehama County.

MINERAL RESOURCES

A tabulation of the mineral production of Glenn County in shown in table 1. Except for natural gas and some chromite and manganese mined in the war years, the mineral production consists almost entirely of sand and gravel used to build roads, driveways and stock corrals and for concrete aggregate. Descriptions of mineral deposits not being worked included in this report are taken from earlier reports and bulletins of the California Division of Mines.

Brick Clay

Brick clays [12] are abundant, especially in T. 19, 22, N. R. 3 W., M. D. M. The clays are chiefly sandy loam. No brick has been made since about 1895, but several yards were operated near Willows previous to that time.

Chromite

Chromite, a black, submetallic mineral with a brown streak and a specific gravity ranging from 4.1 to 4.9 is the only ore mineral found in chrome deposits. The higher grade ore occurs in irregular pods and lenses in dunite or serpentine and no reliable guides to concealed ore bodies have been found. Bodies of low-grade or disseminated ore are intimately mixed with olivine or serpentine and are difficult to mine. The largest known low-grade ore body was mined at the Grey Eagle mine. The possibilities for future production are limited to a few remaining relatively small low-grade deposits and to undiscovered deposits in unprospected areas. There has been no production of chromite from Glenn County since 1944 and the following descriptions of deposits are taken from earlier reports.

The Black Diamond or Grey Eagle [13] group of claims covers a number of chromite deposits in secs. 13, 14, 24, and 25, T. 22 N., R. 7 W., and sec. 19, T. 22 N., R. 6 W., M. D. The Rustless Mining Corporation mined 135,800 long tons of ore from the Grey Eagle mine and 640 long tons from the Black Diamond No. 11 claim between February, 1942 and March, 1944. The ore was mined from open cuts, and about 878,000 long tons of overburden was handled, making the ratio of waste to ore 6.5 to 1. The ore averaged 13 percent Cr_2O_3 and the mill produced 30,806 long tons of concentrates averaging 46 percent Cr_2O_3, indicating a recovery of slightly more than 80 percent of the chromite. The tailing averaged 3.33 percent Cr_2O_3. Exhaustion of the Grey Eagle and Black Diamond deposits forced the mill to close down in March, 1944.

The High Point mine [14] is described as being in the Newville mining district, 32 miles west of Orland. There were three claims on top of a rough barren mountain, where open cuts exposed the main deposit for a length of 250 feet. The ore consisted of irregular streaks of disseminated chromite, and the ore body was said to strike north and dip 60° W. The grade of the ore averaged less than 40 percent Cr_2O_3 and reserves were

[12] Dietrich, W. F., The clay resources and ceramic industry of California: California Div. Mines Bull. 99, p. 79, 1928.

[13] Dow, D. H., and Thayer, T. P., Geological investigations of chromite in California: California Div. Mines Bull. 134, pt. 2, chap. 1, p. 9, 1946.

[14] Thompson, H., Reports on chrome localities in California: made for the U. S. Bureau of Mines as part of the Cooperative War Minerals Investigation in California, in cooperation with U. S. Geological Survey and California State Council of Defense. Unpublished report on file at California State Division of Mines office in San Francisco, 1918.

estimated as 200 tons of blocked out ore, 250 tons of probable ore, and 1,000 tons of possible ore. Apparently the deposit contained very little ore of shipping grade.

The Manzanita mine [15] is in the N.E. $\frac{1}{4}$ sec. 31, T. 22 N., R. 6 W., M. D., on the Cushman ranch. The workings were caved in 1942, but available evidence indicated possible reserves of milling-grade ore in excess of 1,000 tons. The mine yielded 79 long tons of lump ore in 1917.

The Swastika claims [16] in sec. 4, 5, T. 18 N., R. 6 W., M. D., 4 miles north-northwest of Stonyford, were owned by A. E. Brune and leased to A. H. Noyes in 1917. A deposit of exceedingly fine-grained, high-grade ore was opened up by an open cut and a short tunnel. The chromite occurred as small irregular pockets in soft light-green serpentine. About 40 tons of ore had been mined and 10 tons were exposed in the tunnel in August 1917.

Wells Conklin and Ed Williams of Newville [17] held claims on two deposits three-fourths of a mile apart in sec. 3, T. 22 N., R. 7 W., M. D. A chromite lens 2 feet wide was exposed on one claim, and about 100 tons of high-grade ore had been shipped from six lenses on the other claims.

Copper

Rocks stained with copper minerals have been found at several localities in the western part of Glenn County.[18] Some float containing native copper was found in a tunnel on a claim northwest of Elk Creek prior to 1900 and a shaft was sunk 70 feet deep but no vein was discovered. Float containing copper minerals also occurs in sec. 1, 2, 11, 12 and 13, T. 19 N., R. 7 W., M. D.; sec. 18, 19, T. 19 N., R. 6 W.; sec. 18, T. 18 N., R. 6 W.; and sec. 12, 13, 24 T. 18 N., R. 7 W.[19] At the Black Buttes Copper claim [20] in sec. 30, 31 T. 22 N., R. 8 W., M. D., red copper oxide occurs in bunches but no vein has been found. Near the old town of Peckville in sec. 18, T. 18, N., R. 6 W., M. D. much prospecting was done for gold and copper in the 1860's. A development adit 200 feet long was driven in serpentine on a claim 2 miles north of Chrome Mountain in sec. 6 T. 22 N., R. 6 W., M. D. where pieces of native copper weighing as much as 2 pounds were found. [21]

Manganese

Manganese oxides and silicates occur in the chert beds of the Franciscan formation in the southwestern part of Glenn County and deposits of low-grade manganiferous chert occur in sericite schist in the north-

[15] Rynearson, G. A., and Wells, F. G., Geology of the Grey Eagle and some nearby chromite deposits in Glenn County, California: U. S. Geological Survey Bull. 945A, p. 22, 1944.

[16] Taliaferro, N. L., Chromite investigations; descriptions of individual deposits for the California State Council of Defense in 1917-1919. Includes reports by various authors. Unpublished; copies on file at the U. S. Bureau of mines, Washington, D. C., and at the California Division of Mines office, San Francisco, 1918.

[17] Bradley, W. W., Huguenin, E., Logan, C. A., Tucker, W. B., and Waring, C. A., Manganese and chromium in California: California Min. Bur. Bull. 76, p. 147, 1918.

[18] Averill, C. V., Copper, Glenn County mineral resources: California Div. Mines Report 25, p. 420, 1929.

[19] Aubury, L. E., Copper resources of California: California Min. Bur. Bull. 23, pp. 131-132, 1902.

[20] Aubury, L. E., op. cit., p. 132.

[21] Aubury, L. E., op. cit., p. 132.

western part of the county.[22] The production from Glenn County during World War I amounted to 237 tons, which came from the Black Diamond, the Rattlesnake, and the Levensaler and Spier Corporation properties. During World War II the only production came from the K. B. No. 4 deposit. The following descriptions of manganese properties are taken from publications of the California Division of Mines.

Black Diamond Mine.[23] The Black Diamond mine, embracing two claims, is in secs. 14 and 23, T. 18 N., R. 7 W., M. D. Fruto, 30 miles to the southwest, is the nearest shipping point, and is reached by a good road. A body of manganese ore, struck in driving a tunnel on a copper prospect, was at first thought to be very extensive, as a width of 40 feet was exposed. On being stoped, however, it pinched down to a narrow stringer, yielding only about 100 tons of good ore. The ore was shipped in 1917 by A. H. Noyes of San Francisco who has a lease on the property. Although the mine was located about 1900 this was the first ore produced. Work ceased when the lens pinched out. The ore body does not crop out. The owners are A. W. Sehorn, et al., of Willows.

K. B. No. 4 Claim.[24] "The K. B. No. 4 claim is in the N½ sec. 1, T. 18 N., R. 7 W., M. D., on a small ridge just south of Salt Creek, south of Elephant Hill, at an altitude of 1,560 feet. It is 4.7 miles by road west of the main road running between Elk Creek and Stonyford. The claim is reached by turning northwest off the main road at the junction of Salt Creek and Stony Creek, 0.3 mile north of the Brown and Moore Ranch, and 3 miles north of Stonyford. This is the road shown on the Forest Service map as proceeding toward Elephant Ridge. About 2.5 miles up this road, a road turns off to the west and leads directly to the mine. The mine is a total distance of 25.5 miles (21 miles by good road, 4.5 miles by poor road) from the nearest shipping point, at Fruto.

"The K. B. No. 4 claim is one of the four located by H. D. Bruce of Anderson. According to a map by August J. Hoever of Willows, County Surveyor of Glenn County, it is entirely in holdings of the Brown and Moore Ranch of Stonyford. At present it is subleased to M. C. Syar of Vallejo. Three men were working on the property when visited.

"The manganese ore at the K. B. 4 claim lies within a belt of thin-bedded red chert. The chert has a general northwest strike and a southwest dip.

"A cut 120 feet long, 20 feet wide, and 10 to 15 feet deep has been opened northward across the ridge. An area 125 by 100 feet has been scraped off the ridge east of this cut. To the west another cut 60 feet wide and 100 feet long has been opened. Two hundred feet west of the main cut is a V-shaped cut across the ridge, the center of the V enclosing an older caved tunnel.

"The main ore body runs obliquely northwest across the main cut. It has a general strike of N. 30° W., and a dip of 50° to 60° SW. The operators state that the ore bed was 8 feet wide at the bottom of the cut, but the floor of the cut was obscured when observed by the writer. The bed is 4 feet thick on the west wall of the cut. It is exposed for a length of 100 feet. The operators claim that another bed 5 feet wide was encountered just north of the main bed, and this bed does not crop out on either wall of the cut. Toward the north end of the cut were other aggregates of ore, but not as a definite bed, and they probably represent float. On the walls of the cut at this point is a thick regolith, containing blocks of manganese ore and red chert, but no definite bed is exposed. The soil in parts of the cut is 10 feet deep.

"The large area scraped off on each side of the main cut reveals chiefly well-bedded red chert with shale partings. The manganese bed is immediately underlain by a narrow belt of well-bedded manganiferous buff chert. This belt occurs in beds, 1 inch to 4 inches thick. It is somewhat impure, splintery, shaly chert, buff to yellowish white in color. Manganese oxides occur along bedding planes and fractures. The beds are somewhat warped and crumpled. The manganiferous buff chert is underlain, gradationally, by

[22] Jenkins, O. P., and others, Manganese in California: California Div. Mines Bull. 125, p. 77, 1943.
[23] Bradley, W. W., and others, Manganese and chromium in California: California Min. Bur. Bull. 76, p. 32, 1918.
[24] Trask, Parker D., and others, Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, pp. 60-62, 1950.

the extensive well-bedded red chert. On the west wall of the cut the manganese bed is overlain by 3 to 4 feet of hard, flinty, pale-green chert in beds 1 inch to 3 inches thick. This green chert in turn is overlain by well-bedded red chert.

"The manganese ore consists essentially of black oxides. Some of the material is distinctly crystalline. No primary manganese minerals were seen. The ore is cut by small quartz veinlets. Some blocks are composed nearly entirely of black oxides, but more commonly they contain cores and patches of cellular yellow silica, or patches and bands of white chert. In several of the large blocks of ore, 2 or 3 feet in diameter, the outermost few inches seem to be almost free from silica, whereas a third to a half of the inner part may be composed of white chert or patches of silica. While some of the material might run 50 percent manganese, it is believed that a general average of the ore which has been piled up is 40 to 45 percent manganese.

"The V-shaped cut 200 feet west of the main cut encloses a caved tunnel, which was driven south into the ridge. About 5 tons of siliceous ore has been stacked by the side of this tunnel. The south end of the caved tunnel reveals blocks of black oxide ore, but no bedding is exposed. Blocks of ore are also exposed in the walls of the V-shaped cut to the west and to the east, but they occur only as loose blocks and not as a definite bed. They may roughly mark the course of a bed which occurs at depth below the regolith. The east limb on the V-shaped cut shows buff to greenish chert in beds 1 inch to 2 inches thick. The west limb of the cut is 6 feet deep but reveals only a regolith containing fragments of buff, green and red chert.

"The ore in the V-shaped cut is more siliceous than that of the main cut, containing considerable amounts of white chert. It averages about 35 percent manganese. This bed must be different from that of the main cut, unless faulting occurs between them. Between the main cut and the V-shaped cut red chert is exposed. About 100 feet west of the V-shaped cut is sandstone, which evidently overlies the main chert body.

"Approximately 20 tons of ore have been piled up along the road 1 mile east of the mine. Also about 20 to 30 tons are stacked in the canyon just north of the mine. It is said that about 5 tons of ore have been transported to Fruto for shipment."

Rattlesnake Mine.[25] "The Rattlesnake mine is south of Salt Creek in the SE¼ sec. 6, T. 18 N., R. 6 W., M. D. It is 2 miles southeast of the K. B. No. 4 claim (Glenn 8) at an altitude of 1,250 feet. It may be reached by driving up the road toward the K. B. No. 4 claim for 2 miles, from where the workings at the Rattlesnake mine may be seen on a low hill half a mile to the southwest. The mine is located on the Brown and Moore Ranch of Stonyford. It is not being operated at present.

"The development includes a shaft 7 by 7 feet. At present the bottom is 14 feet deep, but it is caved and may have been considerably deeper. According to Bulletin 76, it was 20 feet deep. A drift apparently runs northwest from the shaft for a short distance. A cut 3 to 6 feet deep and 15 feet wide extends for 40 feet southeast of the shaft. Two other cuts, made with a bulldozer, are north and west of the shaft. Neither of these cuts exposes manganese ore. Some 75 tons was shipped in 1918.

"The manganese ore occurs in a massive, yellow-brown quartzose chert. This is the same type of rock as that at the K. B. No. 1 claim (Glenn 7), and is described more fully in the report on that deposit. The ore may also contain bementite. Much of it is covered with a film of black oxide, except where freshly broken. The massive chert is 20 feet thick in the vicinity of the shaft. The black oxide ore occurs in pockets and irregular masses within the massive chert, and in many places is intermingled with chert. No large mass of ore is exposed now, although there is some along the walls of the shaft, especially the northwest wall. Bulletin 76 states that the ore body was 4 to 6 feet wide. Most of the ore occurs near the top (southwest side) of the massive chert body. Some of the ore is hard blue-black psilomelane, but some includes pyrolusite. A few pieces of ore were seen which might run 50 percent manganese, but most of the material now exposed contains yellow-brown chert which would lower the grade considerably.

"Overlying the massive chert and manganese ore to the southwest is 10 feet of thin-bedded green chert, mixed with white and red chert. The chert occurs in beds 0.5 to 1 inch thick with shale partings. A shear zone is between this green chert and the ore body. Southwest of the thin-bedded green chert is a thick-bedded to massive white chert, without shale partings. It occurs in a belt 10 to 15 feet thick, and is overlain to the southwest by sandstone and shale. No exposures were seen northeast of the massive chert and manganese ore.

"The massive chert and manganese ore, thin-bedded green chert, and thick-bedded white chert occur in belts running roughly N. 60° W. The attitude at the shaft is nearly

[25] Trask, P. D., and others, op. cit., pp. 62-63.

vertical, but along the strike in both directions the beds dip to the southwest, indicating that this is the top side. A white chert bed to the southeast srikes N. 60° W., and dips 65° SW.

"The ore body appears to be cut off to the north by a fault trending N. 80° W. A cut run in this direction 15 feet north of the shaft reveals sandstone and shale, highly sheared in part. The chert beds and manganese ore strike into this sandstone and shale. The extent of the massive chert and manganese ore toward the southeast is uncertain, but it is exposed for a total length of 50 feet.

"It seems possible that most of the ore available on this property has been removed. Only 5 or 10 tons of ore is in sight. The situation at depth cannot be determined, as the shaft is partly caved, and it is unknown whether the ore was removed down to the limit of the oxide zone, or whether some may still remain. The main possibility for future development would probably be in reopening the shaft."

Marble

A few small deposits of marble in the sediments of the Coast Range in southwestern Glenn County have been mentioned in earlier reports,[26] but there is no record of production from them.

Natural Gas [27]

The cumulative production of natural gas in Glenn County to January 1, 1950, was 5,322,882 thousand cubic feet.[28] This production was obtained from these separate fields producing from Upper Cretaceous sandstones. Two of these fields are still producing and one has been abandoned.

Willows Gas Field. Natural gas was first produced in Glenn County with the discovery of the Willows gas field in 1938 by the Ohio Oil Company. This small field is about 6 miles northeast of the town of Willows in the Sacramento Valley and was discovered by means of a reflection seismograph survey. Well records from this area show that about 500 feet of the Tehama formation were drilled through before the top of the Upper Cretaceous was encountered at a depth of 1,011 feet.[29] Production was obtained from a sandstone zone occurring at a depth of about 2,250 feet. Two producing wells drilled in this field yielded a total of 25,384 thousand cubic feet of gas. There has been no production since 1945 and the field is presumably abandoned.

Ord Bend Gas Field. The Ord Bend field, approximately 5 miles in a northeasterly direction from the Willows field, was brought in by the Superior Oil Company on August 24, 1943. The discovery well was completed for an initial production of 5,040,000 cubic feet of gas per day in a thin Cretaceous sand at a depth of approximately 3,660 feet. Three wells have been completed in this field which on January 1, 1950, attained a cumulative production of 3,794,806 thousand cubic feet of gas. The field contains 210 acres of proven productive ground.

Afton Gas Field. On February 14, 1944, the Richfield Oil Company completed the discovery well in the Afton gas field, in the southeastern part of Glenn County near Butte City. The initial production from the well was 5,700,000 cubic feet per day and came from a Cretaceous sand

[26] Aubury, Lewis E., The structural and industrial materials of California: California Min. Bur. Bull. 38, pp. 99, 1906.
Logan, C. A., Limestone in California: California Jour. Mines and Geology, vol. 43, pp. 236-237, 1947.
[27] By Lewis T. Braun, Assistant Mining Geologist, California Division of Mines.
[28] Annual Review, Petroleum World, p. 161, 1950.
[29] Williams, R. N., Jr., Willows gas field: California Div. Mines Bull. 118, p. 609, 1943.

*Table 2. Exploratory dry holes, Glenn County, California.**

Location				Name of well	Date started	Year abandoned	Total depth (in feet)	Geology at bottom
T.	R.	Sec.	B.&M.					
22N	5W	4	MD	Stella, E. F., Trustee[2], Tehama Pet. Corp.[1]—No. 1	11–32	'41	4697	Cretaceous
22N	5W	4	MD	Stella, E. F., Trustee—Masterson 1-A	7–39	'43	515	Cretaceous
22N	5W	10	MD	Stella, E. F., Trustee[2]—Murdock-Tehama Pet. Corp.[1]—Simpson 1	3–34	'43	1145	Cretaceous
22N	1W	32	MD	Holly Sugar Corp.—Hamilton 1	5–41	'41	4349	Cretaceous
21N	3W	11	MD	General Pet. Corp. of California—Orland Com. 8-1	12–43	'44	3223	Cretaceous
21N	2W		MD	Superior Oil Co., The—Mary Morris 1	4–44	'44	5054	Cretaceous
21N	1W	31	MD	Superior Oil Co., The—Glenn Comm. Three 72-20	9–43	'43	9178	Basement
20N	5W	23	MD	Williams Oil Co.	----	'02	2900	Cretaceous
20N	2W	18	MD	Ohio Oil Co.—E. E. Willard 1	----	'38	4505	Cretaceous
20N	2W	18	MD	Ohio Oil Co.—E. E. Willard 2	----	'38	2253	Cretaceous
20N	2W	18	MD	Ohio Oil Co.—E. E. Willard 1A	----	'38	6014	Cretaceous
19N	1E	7	MD	Superior Oil Co., The—Dodge Land Co. 2	6–43	'43	5882	Cretaceous
19N	5W	1	MD	Shell Oil Co., Inc.—James 1	8–48	'49	10201	
19N	1W	27	MD	Richfield Oil Corp.—Afton Community 2 2	5–48	'48	2850	Eocene
18N	2W	12	MD	Standard Oil Co. of Calif.—Torres 1	9–44	'44	5322	Cretaceous
18N	1W	2	MD	Richfield Oil Corp.—Afton Community 1 3	6–48	'48	2850	Eocene
18N	1W	3	MD	Richfield Oil Corp.—Afton Community 1 2	5–48	'48	2850	Eocene
18N	1W	5	MD	General Pet. Corp. of Calif.—Norman 1	11–45	'45	3699	Cretaceous

* Data for this table was taken from the following publications: California Div. Mines Bull. 118, p. 639; Petroleum World, Annual Reviews, 1942-1949; Munger Oilogram, Annual Reports, 1949-1950.

at approximately 2,650 feet. On January 1, 1950, this field included 40 proven acres, had two producing wells and had achieved a cumulative production of 1,502,692 thousand cubic feet of gas.

Sites Anticline. The Sites Anticline is one of the dominant features of the geological structure of Glenn County, extending in a north-south direction through practically the entire county. Because of its obvious anticlinal nature this structure has been repeatedly tested for petroleum. The earliest reported test was in 1925 [30] and the latest was in 1950. High pressure gas was encountered in several tests, but in no case was the volume of gas sufficient to be considered commercial. Undoubtedly one factor contributing to the failure of this structure to produce commercially is the high degree of folding and the resulting fractures which probably allowed much entrapped gas to escape. Where the crest of the structure is exposed steeply dipping rocks of Lower Cretaceous age may be seen.

Sand and Gravel

The chief mining activity in Glenn County is the production of sand and gravel used to build and maintain roads, driveways, stock corrals, and for concrete aggregate.

Lloyd Ginter of Chico loads pit-run sand and gravel from a deposit on the north bank of Stoney Creek 2 miles south of Hamilton City. The land is owned by Dick Williams. An Allis Chalmers tractor equipped with a Hough hydraulic loader and a $\frac{3}{8}$-cubic-yard bucket is used to load 5-yard dump trucks. The pit is 8 feet deep including 2 feet of top soil. The pebbles include white quartz, sandstone, quartzite, jasper and andesite. Few pebbles are over 2 inches in size. The pit is operated intermittently and the materials used for roads, stock corrals and concrete aggregate.

Lester G. Madsen operates a pit on the W. H. Dunlap ranch about 2 miles northeast of Willows in sec. 35, T. 20 N., R. 3 W., M.D. The pit is about 250 feet long, 225 feet wide and 15 to 20 feet deep. The gravel is covered with 6 feet of tan-colored sandy soil which contains enough clay to make a good binder for road metal. It includes pebbles of quartz, quartzite, sandstone and red and brown jasper. Few cobbles measure more than 5 inches. The top soil is stripped with a scoopmobile and sold for building roads. The sand and gravel is dug with a dragline equipped with a half-yard bucket and loaded into 5-cubic-yard capacity dump trucks for delivery to customers. Production averages about 1,000 cubic yards of sand and gravel per month.

D. T. McIntosh of Chico operates a gravel pit on the north bank of Stoney Creek, 3 miles west of Hamilton City on land described as lot 1127, T. 22 N., R. 2 W., M.D. The gravel is dug from a bed 4 feet below the surface to water level using a dragline equipped with a half-yard bucket. There are no boulders and few cobbles are over 5 inches. The pebbles include some quartz, sandstone, and red and brown jasper. The material is used to build and repair roads and stock corrals and for concrete aggregate. Production at this pit has ranged from 2,000 to 3,000 cubic yards of gravel per month since June 1950. McIntosh formerly operated a pit on the north bank of Stoney Creek 2 miles south of Hamilton City on land owned by R. C. Williams of Hamilton City.

---

[30] Kirby, J. M., Sites Region: California Div. Mines Bull. 118, pp. 606-608, 1943.

The Orland Sand and Gravel Company is operated by E. B. Bishop and Edward Thomas of Orland. The pit and screening plant is on the north bank of Stoney Creek in the NW $\frac{1}{4}$ sec. 15, T. 22 N., R. 3 W., M.D., about $1\frac{1}{2}$ miles north of Orland and just east of Highway 99W. The gravel is dug from a bed 6 feet below the surface to a depth of 10 feet using a power shovel equipped with a $1\frac{1}{4}$-cubic-yard bucket and loaded into dump trucks of 4-cubic-yards capacity. The material is hauled a few hundred feet to the screening plant where it is dumped into a concrete hopper of 25-cubic-yards capacity. From the hopper the gravel is fed onto a belt conveyor by an oscillating feeder and discharged over a 3- by 8-foot double-deck shaking screen. Water sprays wash the material as it passes over the screen; the excess water is removed by a sand wheel. The screens are interchangeable so that material of several sizes is produced. The screened materials are diverted by slides into six cylindrical, concrete silo-type bins 20 feet in diameter and 30 feet high. Material over $1\frac{7}{8}$ inches in size slides from the screen to a 10- by 16-inch jaw crusher which discharges to a set of 22- by 40-inch rolls. The crushed material is returned to the shaking screens for sizing. The sand and gravel stored in the bins can be drawn onto a belt conveyor and delivered either to railroad cars or to a 4-compartment truck bunker of 60 cubic-yards capacity. Some pit run material is loaded into trucks with a tractor shovel fitted with a 1-yard bucket. The plant has a capacity of 500 cubic-yards in 8 hours.

A Noble semi-automatic concrete batching plant is adjacent to the truck bunker. Three steel aggregate bins with a total capacity of 100 tons are usually filled with $1\frac{1}{2}$- and $\frac{3}{4}$-inch gravel and sand. The specified amounts of sand, gravel and cement can be weighed into a batching hopper beneath the bins and loaded into transit-mix trucks for deliveries to customers. The batching plant has a capacity of 100 cubic yards of concrete in 8 hours. Six men are employed at this plant.

T.P. Thuemler of Willows loads gravel intermittently from the Robert T. Millar pit on the west bank of the Sacramento River east of Glenn, in old Rancho Jacinto, in parcel (or sec.) 66, T. 19 N., R. 2 W. M.D., and from a pit between Walker and Willow Creek a mile east from Willows and a quarter of a mile north from the Glenn road in the SW $\frac{1}{4}$ sec. 2, T. 19 N., R. 3 W., M.D. At the Millar pit the gravel is dug from the surface to a depth of 3 feet by a tractor equipped with a quarter-yard bucket-loader. The pit run material is loaded into a 5-cubic-yard capacity dump truck for delivery. The gravel at the Willow Creek pit is dug with a dragline equipped with a $\frac{3}{4}$-cubic-yard bucket. It includes pebbles of rhyolite, quartz, quartzite and jasper. There are no large boulders. The gravel from these pits is dug when ordered and it is sold as pit run material. It is used for roads, driveways, stock corrals and concrete aggregate.

Wruck Brothers and Davis operate a gravel pit on the west bank of the Sacramento River about 3 miles north of Glenn in the S$\frac{1}{2}$ sec. 42, Jacinto Ranch Survey on land owned by Mary Thomas. The gravel is dug from the surface to a depth of 15 feet with a dragline equipped with a $\frac{3}{8}$-cubic-yard bucket. There are no boulders. The gravel includes pebbles of rhyolite, quartz, quartzite and jasper. It is loaded into dump trucks and hauled 13 miles to a screening plant in Willows. The trucks unload the material onto a stockpile from which it is transferred by dragline to the hopper of a Pioneer screening plant. It is drawn from the hopper into

bucket elevator, lifted 35 feet and discharged onto a 3- by 6-foot, three-deck shaking screen. The screen delivers $1\frac{1}{2}$-, $\frac{3}{4}$-, and $\frac{1}{4}$-inch size products to separate bins from which they are weighed into transit-mix trucks. Cement is added to batches in the trucks. The material over $1\frac{1}{2}$ inch in size is sold to build drains. The batching plant has a capacity of 75 cubic yards in 8 hours.

MINERAL COMMODITY SURVEY

Diatomite

The Holly Sugar Corporation plant at Hamilton City manufactures sugar from sugar beets. They use diatomite, limestone, soda ash and sulfur in the refining process. Diatomite is used as a filtering aid in the thick juice end of the refining process. It is a processed material which has been calcined and finely ground and packed in 50 pound bags by the Johns-Manville Corporation at Lompoc, California. The value of diatomite for use in sugar refining depends on the size and shape of the grains as well as its chemical analysis. Not all California diatomite is suitable for sugar filters.

Limestone

Limestone is burned in vertical kilns to obtain carbon-dioxide gas and lime. They require a dense, high grade limestone 2 to 4 inches in size which will not shatter and clog the kiln when burned. The lime decomposes albumen and other non-sugar substances, and neutralizes acids. The carbon-dioxide gas generated is used to precipitate calcium carbonate and various solid impurities which are filtered from the juice. The chalk-like precipitate is used as a soil conditioner in the beet fields. Limestone is purchased under contract from a quarry in Placer County and delivered to the plant in open railroad cars.

Soda Ash

Soda ash is used to precipitate lime and neutralize the scale formed in the sugar refining process. Commercial soda ash containing 56 percent Na_2O and packed in 100 pound bags is purchased from Trona, California.

Sulfur

Lump sulfur is used for bleaching sugar. It is purchased in crude lump form containing 99.5 percent sulfur from deposits in Texas.

BIBLIOGRAPHY

Allen, J.E., Geological investigation of the chromite deposits of California: California Div. Mines Rept. 37, pp. 101-167, 1941. Glenn County pp. 133-134.

Aubury, L.E., The copper resources of California: California Min. Bur. Bull. 23, 282 pp. 1905.

Aubury, L.E., Structural and industrial materials of California: California Min. Bur. Bull. 38, 412 pp. 1906. Glenn County: brick clays p. 243; chromite, p. 268; marble, p. 99.

Aubury, L.E., The copper resources of California: California Min. Bur. Bull. 50, 366 pp., 1908.

Averill, C.V., Sacramento field division—Glenn County: California Div. Mines Rept. 25, pp. 418-426, 1929.

Averill, Strategic minerals, Sacramento district: California Div. Mines Rept. 39, 1943. Glenn County pp. 74-557.

Beauchamp, M., and Perry, R., California Almanac and State Fact Book, 1948-1949: Bell, California, California Almanac Co., p. 485, 1947.

Boalich, E.S., San Francisco field division—Glenn County: California Min. Bur. Rept. 17, pp. 74-75, 1920.

Bradley, W.W., Mines and mineral resources of portions of California; Glenn County: California Min. Bur. Rept. 14, pp. 197-201, 1915.

Bradley, W.W., Huguenin, E., Logan, C.A., Tucker, W.B., and Waring, C.A., Manganese and chromium in California: California Min. Bur. Bull. 76, 248 pp., 1918. Glenn County, chromium, pp. 146-147.

Crawford, J.J., California Min. Bur. Rept. 12, pp. 412, 1894. Glenn County, chromic iron, p. 36; gold, p. 132.

Dietrich, W.F., The clay resources and ceramic industry of California: California Div. of Mines and Mining Bull. 99, 383 pp., 1928. Glenn County, clay deposits, p. 79.

Dow, D.H., and Thayer, T.P., Chromite deposits of the northern Coast Ranges of California: California Div. Mines Bull. 134, pt. 2, chap. 1, 38 pp., 1946. Glenn County, pp. 9-10.

Eric, J.H., Copper in California: California Div. Mines Bull. 144, 429 pp., 1948. Glenn County, p. 234.

Jenkins, O.P., Crook, T.H., Hudson, F.S., Kroger, R.S., Shepard, O.C., Simons, F.S., Taliaferro, N.L., Trask, P.D., and Wilson, I.F., Manganese in California: California Div. Mines Bull. 125, 1943.

Kirby, J.M., Sites region: California Div. Mines Bull. 118, pp. 606-608, 1943.

Laizure, C. McK, San Francisco field division: California Min. Bur. Rept. 18, pp. 263-264, 1922.

Logan, C.A., Limestone in California: California Jour. Mines and Geol., vol. 43, pp. 236-237, 1947.

Louderback, George D., in Taliaferro, N.L., Chromite investigations: Descriptions of individual deposits for the California State Council of Defense in 1917-1919. Includes reports by various authors. Unpublished; copies on file at the U.S. Bureau of Mines, Washington, D.C., and at the offices of the California State Division of Mines, 1918.

Russell, R. Dana, Reconnaisance geologic map of the Tertiary of northern Sacramento Valley, California: California Jour. Mines and Geol., vol. 35, p. 252, 1939.

Rynearson, G.A., and Wells, F.G., Geology of the Grey Eagle and some nearby chromite deposits in Glenn County, California: U.S. Geol. Surv. Bull. 945A, 229 pp., 4 figs., 6 pls., 1944.

Thompson, H., Reports on chrome localities in California: Made for U.S. Bureau of Mines as part of Cooperative War Minerals Investigation in California in cooperation with U.S. Geological Survey and California State Council of Defense. Unpublished; on file at offices of California State Division of Mines, 1918.

Trask, Parker D., and others, Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, pp. 378, 1950. Glenn County by Ivan F. Wilson, pp. 56-63.

Williams, R.N., Jr., Willows gas field: California Div. Mines Bull. 118, p. 609, 1943.

TABULATED LIST OF GLENN COUNTY MINERAL DEPOSITS

The following table lists Glenn County mineral deposits in alphabetical order by commodity. The number in the first column refers to the map, plate 1.

References given in the last column refer to the bibliography accompanying this report. Only the last name of the author is given. The first number after each name is the abbreviated date of publication as given in the bibliography; the second number, that following the colon, is the page reference.

BRICK CLAY

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Unnamed			19 & 22N	3W	M.D.	Chiefly sandy loam. No production in recent years. (Aubury 06:243; Averill 29:420; Bradley 14:197; Dietrich 28:79)

CHROMITE

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Avery	Oscar Avery					Three claims 18 miles west of Fruto. Low grade disseminated ore. (Dow and Thayer 46:9; Thompson 18.)
1	Black Diamond (Grey Eagle)	Rustless Mining Corporation, New York, New York	13, 14 24, 25 19, 31	22N 22N	7W 6W	M.D. M.D.	Produced 30,806 tons of concentrates averaging 46 percent Cr_2O_3 during World War II. (Allen 41:133-134; Aubury 06:228; Averill 29:420; Bradley 15:198; Bradley 18:146-147; Crawford 94:36; Dow and Thayer 46:9,31; herein)

2	Black Diamond No. 6 (Loleta)	K. I. Cooper, Willows	SW¼ 24	22N	7W	M.D.	Produced a small amount of disseminated ore. (Allen 41:133-134; Averill 29:420; Bradley 15:198; Crawford 94:36; Dow and Thayer 46:9-31)
	Boulder City (Chrome King No. 1, No. 2, No. 3)	A. R. Bickford, Roseville	19	19N	6W	M.D.	See Black Diamond. Lenses in serpentine. (Averill 43:557)
3	Conklin and Williams	Wells Conklin and Ed. Williams, Newville	3	22N	7W	M.D.	100 tons mined from 6 lenses. (Averill 29:420; Bradley 18:147; Dow and Thayer 46:10-31; herein)
	Grey Eagle						See Black Diamond
	Highpoint (Hooligan)	R. B. Millsaps	31	22N	6W	M.D.	Newville district 32 miles west of Orland. Irregular streaks of disseminated chromite. (Dow and Thayer 18:10,31; herein)
	Hooligan						See Highpoint
	Katherine						See Black Diamond
	Diamond group						See Black Diamond No. 6
	Loleta						See Black Diamond group
	Luce claims	A. Luce, Willows	10 or 12	21N	7W	M.D.	Some ore mined in 1918. (Averill 29:420; Bradley 18:219)
4	Manzanita	F. M. Burrows	NW¼ 19	22N	6W	M.D.	Milling grade ore. (Dow and Thayer 46:10,31)
	Manzanita Extension	Lena Burrows	NW19	22N	6W	M.D.	Disseminated ore. (Dow and Thayer 46:31)
5	Manzanita	Cushman, C. & N.	NE¼ 31	22N	6W	M.D.	Disseminated ore. (Dow and Thayer 46:31; Rynearson and Wells 44:22; herein)
	Mary Ellen						See Black Diamond
6	Swastika	A. E. Brune	4, 5	18N	6W	M.D.	Small irregular pockets of fine-grained high-grade ore. (Dow and Thayer 46:31; Taliaferro in Louderback 18; herein)
	Whitlock and Oaks						See Black Diamond

COAL

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Glenn County Oil and Coal Company						Several small coal veins on west side of valley. (Averill 29:420; Bradley 15:197)

COPPER

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
7	Black Buttes		30, 31	22N	8W	M.D.	Cuprite in bunches but no vein. (Aubury 02:132; 08:159; Eric 48:234; herein)
	Brisco (Hudibras)		1, 2, 11, 12, 13	19N	7W	M.D.	Copper "indications" in serpentine. (Aubury 05:131; 08:158; Eric 48:234)
	Hudibras						See Brisco
	Knight	Assessed to D. A. & K. L. Gilman, February 1951	6	18N	6W	M.D.	Some copper "indications" showing. (Aubury 05:132; 08:158; Eric 48:234)
	Lehorn	Assessed to D. A. & K. L. Gilman, February 1951	6	18N	6W	M.D.	Native copper float; 200 foot adit in serpentine. (Aubury 05:132; 08:159; Eric 48:234)
	St. John		18	18N	6W	M.D.	"Indications." (Aubury 05:132; 08:158; Eric 48:234)

GOLD

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Milsap						Between Grindstone Creek and Milsap Creek. Quartz prospect. (Crawford 94:132; Averill 29:421)
	Titanic		24?	21N	7W	M.D.	15 claims located for gold, silver and copper in April 1922 on Atwood gulch, ½ mile west of the Geo. Gillaspy ranch. Narrow quartz stringers in Franciscan formation. (Averill 29:421; Laizure 22:263)

GRANITE

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Talbot granite	T. Talbot Anderson, San Anselmo	8	18N	4W	M.D.	A dike of syenite in sandstone has been reported. (Aubury 06:28; Averill 29:421; Bradley 15:198)

MANGANESE

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Big Stony Creek (Rockridge)	E. J. Hansen?	25 or 26	18N	7W	M.D.	Manganiferous chert. (Jenkins 43:113; Wilson in Trask 50:56)
8	Black Diamond (North Star)	A. W. Sehorn, Willows, California. Leased to A. H. Noyes in 1917	14, 23	18N	7W	M.D.	A. H. Noyes of San Francisco shipped 100 tons in 1917. Lens pinched out. (Averill 29:421; Bradley 15:198; Bradley 18:32, 92; Jenkins 43:77, 113; Trask 50:57; herein)
9	Brown and Moore	Alex Brown, Walnut Grove	36 N½ 1	19N 18N	7W 7W	M.D. M.D.	Manganiferous chert. Some pockets of low grade silicious black oxide. (Averill 43:557-558; Jenkins 43:113; Wilson in Trask 50:57)
10	B.S. No. 1	W. E. Sale, Charles A. Butler	26	21N	8W	M.D.	Black manganese oxide film and veinlets in dark green slaty chert. (Jenkins 43:113; Wilson in Trask 50:57-58)
	Elephant Hill	Charles A. Butler, Vesta Kellar	?	19N	7W	M.D.	25 miles from railroad. From files of U.S. Geological Survey, 1942.
11	Hummingbird	L. D. Stall, H. A. Butler, Raymond Butler	36	21N	7W	M.D.	Black manganese oxide film and veinlets in dark green slaty chert. (Jenkins 43:113; Wilson in Trask 50:59)
12	K.B. No. 1	H. D. Bruce, Brown and Moore	S½ 35	19N	7W	M.D.	Black manganese oxide associated with yellow-brown chert bands. (Jenkins 43:113; Wilson in Trask 50:59)
13	K.B. No. 4	H. D. Bruce, Brown, and Moore, M. C. Syar lessee	N½ 1	18N	7W	M.D.	Black manganese oxides in bedding planes associated with red chert. Active during World War II. (Jenkins 43:113; Wilson in Trask 50:50-62; herein)

	Levensaler and Spier						Probably in T. 20 N., R. 6 W., M.D. Records indicate production of 62 tons of 42 percent manganese in 1917. Files of U.S. Geological Survey, 1918.
	Moore, Brown						See Brown and Moore
	North Star						See Black Diamond
14	Rattlesnake	Brown and Moore (Formerly A. H. Noyes, H. B. Chase, and T. Norris. Ground was assessed to D. A. & K. L. Gilman in February 1951.	SE¼ 6	18N	6W	M.D.	Manganese oxides occur in a massive yellow-brown chert. (Averill 29:421; 43:557; Bradley 18:32-33; Jenkins 43:114; Wilson in Trask 50:62-63; herein)
	Rockridge						See Big Stony Creek

MARBLE

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
	Brown		8?	18N	6W	M.D.	Northwest of Rockville—"Serpentine marble exposed." Undeveloped. (Aubury 06:99; Averill 29:421; Bradley 15:198; Logan 47:237)
	Daniels		21	18N	6W	M.D.	"Ledge of white marble outcrops along the east side of Stony Creek" (Aubury 06:99; Averill 29:421; Bradley 15:198; Logan 47:237)
	Nye		1, 12	18N	8W	M.D.	"A deposit of onyx marble is reported near the Lake County line." (Averill 29:421; Bradley 15:198)

MINERAL SPRINGS

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
15	Alder Springs	U.S. Forest Service	24	21N	8W	M.D.	Formerly operated as a resort. (Averill 29:423; Bradley 15:198)
16	Salt Spring Valley Spring	D. A. & K. L. Gilman	8	18N	6W	M.D.	Used as salt licks for range cattle. (Averill 29:423; Bradley 15:199)

SAND AND GRAVEL

Map number	Claim, mine, or group	Owner name, address	Location				Remarks
			Sec.	T.	R.	B & M	
17	Ginter, Lloyd	R. C. Williams, Hamilton City					Unsubdivided land on Stony Creek, 2 miles south of Hamilton City. Pit run material; herein.
18	Glenn County Gravel Pits		4, Glenn Ranch survey:				
			6, 24	19N	3W	M.D.	Now idle. Gravel was dug with a dragline and used to build roads. (Averill 29:423; Boalich 20:74; Bradley 15:200)
			12, 15	20N	3W	M.D.	
			29, 35	20N	3W	M.D.	

19	Madsen, Lester G.	W. H. Dunlap, Willows	35	20N	3W	M.D.	Pit run material, herein.
20	McIntosh, D. T.	Wells Fargo Bank & Trust Co., San Francisco	Lot 1127	22N	2W	M.D.	Pit run material, herein.
21	Orland Sand and Gravel Co.	E. B. Bishop & Edward Thomas, Orland	NW¼ 15	22N	3W	M.D.	Pit run and screened material. Transitmix concrete. (Averill 29:423; Boalich 20:24-74; Bradley 15:200-201; herein.)
22	Southern Pacific Railroad Company	Southern Pacific Railroad Company	13	22N	3W	M.D.	Pit run material was mined with a dragline and used for ballast. (Averill 29:423; Boalich 20:75; Bradley 15:200-201)
23	Thuemler, T. P.	R. T. Millar, Glenn	66	19N	2W	M.D.	Pit run material. A mile east of Glenn. Unsubdivided tract; herein.
24	Thuemler, T. P.	M. L. Davis	W½ SW¼	19N	3W	M.D.	Pit run material; herein.
	Willows City Pit		11	19N	3W	M.D.	Formerly operated by the City of Willows. Idle in recent years. (Averill 29:426; Boalich 20:75; Bradley 15:201)
25	Wruck Brothers and Davis	Mary Thomas, Chico	S½ 42	Jacinto	Ranch		Sand and Gravel. West bank of Sacramento River, 3 miles north of Glenn Unsubdivided tract. Pit run and screened material. Transit-mix batching plant at Willows; herein.

ANNUAL REPORT OF THE STATE MINERALOGIST CHIEF OF THE DIVISION OF MINES

FOR THE 102d FISCAL YEAR JULY 1, 1950 TO JUNE 30, 1951

By Olaf P. Jenkins *

OUTLINE OF REPORT

Illustrations

* State Mineralogist and Chief of the Division of Mines, Department of Natural Resources.

LETTER OF TRANSMITTAL

GENERAL WARREN T. HANNUM
Director, Department of Natural Resources
Sacramento, California

SIR: I have the honor to transmit herewith for reference to Governor Earl Warren the anual report of the State Mineralogist, Chief of the Division of Mines for the 102d fiscal year, July 1, 1950 to June 30, 1951.

This is in accordance with the requirement provided in the amended Section 2203 of the Public Resources Code.

In describing the activities of the Division of Mines, sections of the Public Resources Code are quoted, to give documentary evidence of what is required of the Division of Mines, and to show that the program it has followed adheres to the Code.

During the past fiscal year there have been two major factors which have greatly affected the program of work: (1) national defense and (2) continued growth in the state's population.

Because the chief function of the Division of Mines is to secure data and to give authoritative technical information to a mineral-interested public, it is interesting to see how useful such an organization becomes during a period of national defense, and how necessary it is that the Division should cooperate with the National Government and keep in step with the growing population which creates new uses and new markets for mineral raw materials.

In a state where there is such a wide diversity of minerals and such an abundance of useful raw mineral and rock materials, it behooves the organization to become well acquainted with all the geologic conditions relative to their occurrence, to determine their usefulness, both current and potential, to understand how best they may be developed, and finally to provide both user and producer with helpful and authentic information. In this manner the state's natural wealth is expanded.

With raw mineral materials numbering over three score available, with all manner of geologic conditions under which they may form, with mineral markets growing both in value and scope, it is no wonder that the value of California's mineral production has for the past three years (1948, 1949, and 1950) kept well above the one billion dollar mark, twice the annual production of five years previous and nearly three times the production of twenty years ago. As the population has doubled, the value of minerals produced has trebled.

That the Division of Mines has had an important part in helping wise development of the state's mineral resources is testified by scores of letters from enthusiastic and appreciative persons who have received the technical services of the Division of Mines and availed themselves of its various publications.

Respectfully submitted,

OLAF P. JENKINS
State Mineralogist and
Chief of the Division of Mines

Ferry Building, San Francisco
September 1, 1951

ABSTRACT

In no time in its history was the Division of Mines more active or better organized than during the fiscal year 1950-51. Its services and its publications have been greatly improved as well as enlarged in scope and number; its operations are more efficient; the information it secures and distributes has been assembled in a more usable form.

Personal information service was given by letter, telephone, and conference to over *one hundred thousand persons*. Each month the pamphlet *Mineral Information Service* was distributed to about 13,000 people. It helped to sell the publications of the Division, receipts of which totaled $18,687.15 for the fiscal year.

The laboratory identified 3,151 mineral samples for the public. To the schools were sent 143 sets of mineral specimens for use and display. The library of over 8400 volumes and mineral exhibits of over 21,000 specimens were enlarged and improved. More than 60 groups of school children, as well as hundreds of other persons, visited the mineral exhibits. The library reading rooms served the public constantly.

Staff members of the Division attended more than 200 public gatherings and gave talks, principally on the mineral resources of the state.

Mineral utilization surveys were started, mineral inventories were continued, basic geologic mapping was carried on in various parts of the state. Mineral commodity surveys were especially active because they were particularly needed in the national defense program.

The public has shown great appreciation for the work and services of the Division of Mines. A revision and re-publication of the state geologic map is in demand. Continued basic geologic surveys and mineral commodity studies are needed. The new mineral utilization survey has proved to be very much needed and desired by both user and producer of minerals.

The Division of Mines has been responsible for initiating new developments, activities, industries, and significant new interests in the mineral resources of California. It has played an important role in increasing the wealth of the state.

The total annual value of minerals produced in the state continues to be over one billion dollars. The most rapid advancement in value of minerals produced was made by the nonmetallic producers.

INTRODUCTION

Public Resources Code:

"2203. The State Mineralogist shall make an annual report to the Director for transmission to the Governor on or before the fifteenth day of September next preceding the regular session of the Legislature."

In describing the activities of the Division of Mines for the 102d fiscal year, July 31, 1950 to June 30, 1951, the same general arrangement is followed as in the previous annual report of the State Mineralogist. Functions and accomplishments are summarized. These statements are accompanied by citations from the Public Resources Code in order to give documentary evidence of the fact that the program of work adheres to the requirements of the Code.

In its scope this report covers the following subjects: (a) organization, personnel, and support; (b) informational service, exhibits, library and publications; (c) research work in mineral statistics and inventories, mineral utilization and economics, mineral commodity studies; (d) geologic mapping; and (e) cooperation with other agencies.

In this issue of the California Journal of Mines and Geology also appears an abstract of a report covering the results of a statewide mineral commodity survey, intended to summarize the salient current activities in the mineral industry with special reference to national defense.

ORGANIZATION OF THE DIVISION OF MINES

Headquarters of the Division of Mines are in the Ferry Building, San Francisco, a city in which are located the offices of practically all the great mining companies of the nation. Offices, library, and exhibits occupy the north wing of the mezzanine floor. Slip number five, where in former days ferry boats docked, has been rebuilt to accommodate laboratories (for physical, microscopic, and chemical determinative work), a darkroom housing the spectrograph, a storeroom for duplicate exchange volumes of the library, and offices for members of the field staff. On the ground floor near the north end of the building are the mailing section and stock rooms, together with the Division's garage.

The following outline indicates how the different functions of the Division of Mines are activated by the formation of different sections and controls which are in turn administered under three principal branches of supervision: Administrative Branch, Geologic Branch, and Mining Engineering Branch. With the Chief and two Supervising Mining Geologists, it is possible always to keep at least one of the three in charge of the headquarters office while the other two are at liberty to go into the field. In order to serve particularly the mining interests in the Sierra Nevada and Klamath Mountains, informational branch offices are located respectively in Sacramento (State Office Building No. 1) and Redding (State Forestry Building). The large market area of Los Angeles, surrounded as it is by a vast region endowed with an unsurpassed mineral wealth of fuels, nonmetallics, salines, and metals, has required the services of a branch office of the Division of Mines. The Los Angeles Branch Office has grown into a very useful and significant part of the organization, maintaining a separate small library and a mineral exhibit of special local interest. It occupies a suite of rooms on the fourth floor of the State Building, 217 West First Street, Room 402B.

No definite district boundaries are now maintained by the branch offices of the Division of Mines, for the reason that each informational office should serve the mineral interests of the state as a whole. In making statewide commodity surveys, no restrictions can be placed on coverage of the survey, but close touch is always kept with the nearest branch office as well as with headquarters. The laboratories, large library, and mineral collections in San Francisco are essential in the preparation of reports by all members of the staff. The offices in Los Angeles, Sacramento, and Redding are intended to give a broader and more personal information service to individuals in their immediate vicinity.

OUTLINE OF THE ORGANIZATION OF THE DIVISION OF MINES

Administration Branch (San Francisco)

- Personnel control
- Office management control
  - Fiscal control section
  - Maintenance and service section
    - Stock and mailing
    - Mailing lists
    - Janitor service
- Publications control
  - Editorial section
  - Drafting and illustrations section

Geologic Branch (San Francisco)

- Mineralogic control
  - Public service laboratory section
  - Research laboratory section
  - Exhibits section
- Mineral commodity survey
  - Metallics section
  - Nonmetallics section
  - Mineral fuels section
- Geologic survey
  - Geologic mapping section
  - Guidebook section

Mining Engineering Branch (San Francisco)

(With small branches in Sacramento and Redding)

- Public information control
  - Library section
  - Information section
  - Mineral statistics section
  - Ore buyer's licensing
- Mining activities survey
  - County activities in northern California
- Mineral utilization survey
  - Mineral markets in northern California

Los Angeles Branch Office

- Public information control
  - Information, library, and exhibits
- Mining activities survey
  - County activities in southern California
- Mineral utilization survey
  - Mineral markets in southern California
- Geologic survey

PERSONNEL

Public Resources Code:

"2201. The State Mineralogist shall employ competent geologists, field assistants, qualified specialists, and office employees when necessary in the execution of the plans and operations of the division under this chapter."

Technical employees in the Division of Mines are now graded as follows: Mining Geologic Aid, Junior Mining Geologist, Assistant Mining Geologist, Associate Mining Geologist, Senior Mining Geologist, and Supervising Mining Geologist. In addition, there are technical editors, draftsmen, and a librarian.

The personnel of the Division of Mines is, therefore, distinctly of the professional type. During the 1950-51 fiscal year, the Division of Mines maintained a staff of 29 technical employees and 21 non-technical employees, a total of 50. Of this total number, 24 technical employees and 18 non-technical employees work in the San Francisco headquarters office. In the Los Angeles Branch Office there are one non-technical and four technical employees; during the 1951-52 fiscal year, this staff will be increased to six technical employees and two non-technical employees. The Redding branch office has one technical and one non-technical employee. It also maintains space for a field division of the cooperating staff of the United States Geological Survey. The Sacramento office of the Division has been operating with at least one technical employee supplied by the San Francisco office, assisted by one non-technical resident employee. Because several members of the staff are engaged in work in

the Sierra Nevada, the informational service in Sacramento has not been done continuously by any one employee. A rotating staff has kept the office supplied with a person to provide informational service.

Once a month the entire technical staff meets in the headquarters office of San Francisco and benefits by interchange of information gained through field surveys and other research studies. Integration and coordination of the work is thus made possible, and supervision of all the projects is centralized. In this manner, efficiency is maintained in the administration of the work, which results directly in improved service to the public.

Monthly reports of progress on assignments are supplied the Chief each month by each member of the technical staff. Besides the routine work of the Division, each technical employee is assigned a major problem of field and office research, which is eventually to result in the preparation of a report for publication.

FINANCIAL STATEMENT

Fiscal 1950-51 *

Total salaries and wages		$188,025.62
Operating expenses:		
Freight, cartage, and express	$ 810.03	
Telephone and telegraph	1,863.58	
Toll calls	466.33	
Light, heat, and power	1,291.74	
Rent of building space	13,407.00	
Repairs and maintenance of structures and other facilities	1,026.23	
Office supplies and services	5,243.19	
Postage	4,417.68	
Photography supplies and services	1,208.57	
Blueprinting	348.49	
Printing bulletins and maps	62,620.36	
Printing, general	1,369.39	
Technical reports	9,999.00	
Auto parts and services	2,558.88	
Auto gas, oil, tires and tubes	3,474.19	
Travel	12,340.06	
Auto mileage	27.20	
Laboratory supplies and services including assays	2,608.09	
Library supplies and services	811.47	
Exhibits supplies and services	466.64	
Total operating expenses		126,358.07
Equipment:		
Automobile	$ 1,923.35	
Field	284.76	
Laboratory	492.21	
Library	1,301.40	
Exhibits	116.07	
Office	3,612.99	
Total Equipment		7,730.78
Total expenditures		322,114.47
Special item: Geological exploration in cooperation with U. S. Geological Survey		50,000.00
Grand total		$372,114.47

* Some of the figures given are approximate, because not all bills for the fiscal year were paid at the time this report was prepared.

INFORMATION SERVICE

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State mineralogist shall: . . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State . . ."

By means of its publications, the Division of Mines is able to give authentic information to the greatest number of people; but there is a constant demand for information made by persons who call at the offices, or who write letters of inquiry. Much of the time of every member of the staff is devoted to giving oral information or to writing letters. Two mining geologists are occupied full-time in the main information room at the San Francisco headquarters. In the three branch offices this same service for the public is maintained, but on a smaller scale. *Mineral Information Service,* the Division's monthly pamphlet, has proved to be invaluable in answering questions of special current interest.

The Korean situation and resultant enlarged national defense program in 1950 increased the requests for information, particularly data concerning strategic minerals. Close cooperation with Federal agencies placed the Division in an excellent position to provide authentic and timely information on the defense minerals program.

During the 1950-51 fiscal year approximately 20,000 personal calls and 18,000 pieces of correspondence were handled in the San Francisco office. The number of telephone calls exceeded the number of personal interviews. Guides were provided to 60 groups of school children and youth organizations totaling 1,900 persons.

At the Los Angeles office personal services amounted to 15,625, of which 45 percent were telephone calls, 41 percent oral inquiries and interviews, and 14 percent mail requests.

Personal services at the Sacramento and Redding offices amounted to 1,569 and 2,330, respectively, including telephone calls. Many of the mail inquiries received at the Sacramento office were sent to Headquarters office in San Francisco, where research facilities permit more expeditious handling.

The inquiring public consists principally of operating companies, prospective operators, investors, prospectors, professional geologists and mining engineers, chambers of commerce, school teachers and students, lapidaries, mineral collectors, newspapers, and governmental agencies. Questions asked orally are many and varied. The Division has prepared a typed *Sourcebook of Information,* copies of which are distributed to its several information desks. Each month the source book is revised by contributions from staff members. This source book together with *Mineral Information Service* and Bulletin 156, *Mineral Commodities of California,* has served a useful purpose in giving satisfactory answers to various inquiries. Many of the inquiries concern the possibility of a moratorium or extension of the time required to do assessment work, procedures in requesting federal assistance, information on mineral occurrences and operations (especially of strategic minerals—tungsten in particular), information on mineralized areas, mineral identification, possible markets for minerals, and possible sources of minerals for use in industrial concerns.

PUBLIC APPEARANCES

Throughout the fiscal year various members of the technical staff have by request appeared before public gatherings to give information concerning mineral resources, geology, and other subjects. Use has been made of photographs taken by members of the staff during their survey work. Projection of color-slide illustrations has proved very effective. Technical motion pictures obtained from the U. S. Bureau of Mines and various industrial concerns have also proved to be very popular. In every case, the public has expressed appreciation of these appearances. The following summary shows the extent of this service during the 1950-51 fiscal year. Figures in the righthand column represent the number of appearances of staff members at each public gathering.

Technical groups

American Institute of Mining Metallurgical Engineers (papers presented)	5
American Association of Petroleum Geologists (papers presented)	2
American Ceramic Society (papers presented)	4
Engineers Club of San Francisco (film shown)	1
Gemological Institute of America (talk given)	1
Geological Society of America (papers presented)	1
Western Chemical Market Research group (talk given)	1

Civic organizations

Anderson Rotary Club, Redding (talk given)	1
Los Angeles Chamber of Commerce Chemical Market Research Committee (talk)	1
Los Angeles Chamber of Commerce Mining Committee (talks given)	10
Redding Chamber of Commerce Natural Resources Committee (talk given)	1
San Francisco Chamber of Commerce Mining Committee (talks given)	10
Trinity County Planning Board (talk given)	1

Mining groups

California Hydraulic Mining Association (two talks, one film showing)	4
Mining Association of the Southwest	2
Oregon Mining Association (cooperating with Northern California miners)	1
Western Mining Council	4

Fairs and mineral shows

California Federation of Mineralogical Societies Gem and Mineral Show
California State Fair (mineral exhibits judged)
Monterey Bay Mineral Society Annual Mineral and Gem Show
San Bernardino County Fair
San Mateo Gem and Mineral Show
Representatives were in continuous attendance throughout the above shows, exhibiting mineral specimens, demonstrating Geiger counter, giving information, and selling publications.

Mineral and geological societies

Branner Geological Club (talk given)	1
Calaveras Gem and Mineral Society (field trip conducted)	1
California Institute of Technology Geological Society	1
East Bay Mineral Society (talk given)	1
LeConte Geological Club (talk given)	2
Los Angeles Dana Mineral Club (talk given)	1
Mineralogical Society of Southern California (talk given)	1
Monterey Bay Mineral Society (films shown)	1
Northern California Geological Society (weekly luncheon meetings)	48
Northern California Mineral Society (talk given, field trip conducted)	3
Palo Alto Geological Society (4 field trips conducted, demonstration given)	6
San Fernando Valley Mineral and Gem Society (talk given)	1
Shasta Gem and Mineral Society (talk given)	1

Educational

California Conservation Council	1
Conservation Education Committee of Natural Resources	2
Conservation of Natural Resources, Second Regional Conference	1
Conservation classroom talks (Sixth grade group and San Jose State College)	3
Los Angeles City Board of Education Institute (talks given)	4
San Francisco College for Women (conducted field trip)	1
Palo Alto Evening High School geology class (petrographic demonstration)	1

Miscellaneous

California State Employees Association (talk given)	1
Clay Conference (1952) Committee	1
Girl Scouts of America (field trip conducted)	1
Golden Gate Breakfast Club (answered questions on mineralogy)	1
Sierra Club (talk given, field trip conducted)	2
Trinity Church Club (talk given)	1
Walnut Creek Methodist Church (talk given, field trip conducted)	2
Total motion picture loans, 35; showings 31	66

PUBLIC APPRECIATION OF SERVICES

Although most expressions of appreciation of the services of the Division of Mines are given orally, there are scores of unsolicited letters in the files which attest to the fact that the Division has been of distinct assistance to many agencies engaged in the development of the state's mineral resources. The services of the Division are always rendered with a feeling that it is "all in the day's work," and with hardly a thought of learning further whether the services result in development of new industries.

In examining the files, however, we find 55 letters praising Bulletin 156, *Mineral Commodities of California*, 23 praising all our bulletins and journals, many others expressing continued praise for Bulletins 118, 141, and the state geological map and 600 letters as well as many hundreds of cards showing special enthusiasm for *Mineral Information Service*. After circularization of the mailing list of over 11,000, nearly 3500 persons were dropped because of failure to respond; but after the Division sent out a second notice more than 1500 notified the Division to continue sending the pamphlet and complimented the services received. In practically every instance the card or letter was signed by the president of the company or by some professional person in charge. Since circularization was made, additional requests for *Mineral Information Service* have brought the mailing list back to over 11,000.

EXAMPLES OF RESULTS OF SERVICES

In some cases the Division has actual record that its services were effective in bringing about new activities in the mineral industry. Typical examples are as follows:

(1) An asbestos producer was aided in finding several buyers for his product.

(2) A manganese user was helped to find a producer and as a result an industry started.

(3) A roofing granules industry started through information provided by the Division of Mines.

(4) In a certain bentonite deposit, another material in the deposit was shown to be of commercial value, thus increasing productivity.

(5) High-grade clay deposits discovered by the Division were developed by a company.

(6) Geologic investigation of the clay deposit gave information valuable to a major oil company in its exploration work.

(7) Discovery and identification of commercial asbestos has led to a drilling program.

(8) Ground water of value in mining operations was discovered in a clay area.

(9) Exploration of limestone deposits by a company was initiated by the Division of Mines, resulting in the finding of valuable material.

(10) Exploration programs have been outlined and carried on by several mining companies after initiation by the Division of Mines.

(11) Operators to develop prospects in copper, tungsten, and other minerals were found.

(12) New perlite deposits in Napa and Sonoma Counties discovered and reported by the Division are now in profitable operation.

(13) New perlite deposits in San Bernardino County are near production because of information given by the Division.

(14) New quicksilver mines have been put in operation to serve as a permanent source of supply for a chemical concern as a result of work by the Division.

(15) A large government loan for developing an old quicksilver mine was secured on recommendation of geologists on the cooperative program.

(16) Scheelite—an important ore mineral of tungsten—was identified by the Division from a deposit in the Coast Ranges of California; this mineral had hitherto never been reported in the Coast Ranges.

(17) Increased activity in talc mining, gypsum development, prospecting for strategic minerals, and exploration for new commercial minerals in pegmatite bodies has resulted from work by the Division of Mines.

(18) Information in publications by the Division has stimulated the search and drilling for oil by large companies.

(19) Maps supplied by the Division of Mines have assisted certain planning agencies in their industrial development.

(20) Assistance has been given to numerous agencies in locating new sources of mineral commodities.

MINERAL LABORATORY

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a laboratory in San Francisco for the purposes provided in this chapter."

Throughout the fiscal year 1950-51, a total of 3151 samples were received for mineral determination and reported on by the laboratory of the Division of Mines.

With the country at war, a large percentage of the samples submitted were tested for such important defense materials as tungsten, manganese, chromium, copper, lead, zinc, iron, the rare-earth elements, and radioactive minerals. The excitment created in 1949 by the discovery of jadeite in San Benito County and of nephrite in Marin County was renewed by additional finds in 1950-51 of nephrite and jadeite along the Eel River

and several of its tributaries in Mendocino County. Because of these new finds, a large number of jade-like minerals and other semi-precious materials were received for identification.

Various forms of research carried on by staff members drew heavily upon the facilities of the research laboratory. Spectrographic analyses were made of ore, mineral, and rock samples collected in connection with commodity studies of fluorspar, rare-earth elements, clay, California jade, and solid fuels. The petrographic laboratory was also a focal point of activity. Numerous thin sections and mineral grains were studied under the microscope.

MINERAL EXHIBITS

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum . . . in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . .

(c) Make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes."

"2206. The State Mineralogist may prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the State."

The museum of the Division of Mines contains well over 21,000 mineral, rock, and ore specimens donated by residents of the state and other persons interested in preserving outstanding rock and mineral samples. Many of these fine specimens are from mining districts in California which are now producing large quantities of raw metallic and nonmetallic mineral commodities for use in industries. Some specimens come from abandoned mining districts, recorded in publications. Other specimens are from other states or from foreign countries.

The museum is open to the public, whose general interest in the rock and mineral raw materials of California is well indicated by the increase in the daily number of inquiries concerning the exhibit. Although considerable time was spent renovating the exhibits, a great deal of work remains to be done before the museum will be in first-class condition.

On various occasions throughout the year, mineral shows and conventions were attended by staff members of the Division of Mines, where they exhibited some of the useful minerals of California, distributed publications, and answered numerous questions. Often they were asked to demonstrate the action of the Geiger counter on radioactive minerals, and the use of the petrographic microscope in studying properties of minerals.

A total of 143 sets of minerals and rocks were provided elementary schools throughout California. This service represents an increase of 86 percent over the fiscal year 1949-50. Not all requests could be filled because of insufficient personnel for the work. The increase resulted from several factors, chief among which were an increasing public interest in California's minerals and their conservation and an increasing recognition of the educational value of providing school children at the elementary level with a knowledge of rocks and minerals.

MINERAL ACCESSIONS TO THE MUSEUM

Public Resources Code:

"2204. The State Mineralogist may receive on behalf of this State, for the use and benefit of the division, gifts, bequests, devices, and legacies of real or other property and may use the same in accordance with the wishes of the donors. If no instructions are given by the donors, the State Mineralogist shall manage, use, and dispose of the gifts, bequests, and legacies for the best interest of the division and in such manner as he may deem proper."

Many mineral specimens were donated to the museum. Among the most significant are the following:

21388 OBSIDIAN (Volcanic Glass) spheres. Donor: T. Earl Watley, 1950.

21389 LIMESTONE. From Argus Range, Inyo County, California, about 15 miles north of Trona. Donor: R. F. Henley, 1950.

21390 ALLANITE ($(Ca,Ce,La)_2(Al,Fe''',Mg)_3(OH)Si_3O_{12}$). From southern Big Horn Mountains, Wyoming. Donor: F. W. Osterwald, 1950.

21391 CALCITE ($CaCO_3$). Cleavage fragment showing curved surfaces. From Lone Star mine, Mono County, California. Donor: Charles W. Chesterman.

21392 ACTINOLITE ($(Ca_2(Mg,Fe)_5Si_8O_{22}\cdot(OH)_2)$ with talc. From large boulder near U. S. Highway 101 south of Hopland, Mendocino County, California. Donor: M. Vonsen, 1950.

21393 GOLD (Au), on quartz (SiO_2) with pyrite (FeS_2). From Empire mine, Grass Valley, Nevada County, California. Donor: Gorden M. Buck, 1950.

21394 URANOPHANE ($Ca(UO_2)_2Si_2O_7\cdot 6H_2O$). From New Mexico, about 10 miles north of Grants. Donor: Tom O. Evans, 1950.

21395 TYUYAMUNITE ($Ca(UO_2)_2(VO_4)_2\cdot nH_2O$). From New Mexico, about 10 miles north of Grants. Donor: Tom O. Evans, 1950.

21396 TITANIUM (Ti) metal and sponge. Made by U. S. Bureau of Mines at Boulder City, Nevada. Donor: H. A. Doerner, U. S. Bureau of Mines, 1950.

21397 GOLD (Au) crystallized with tetrahedrite ($4Cu_2S\cdot Sb_2S_3$). From Sixteen-to-One mine, Alleghany, Sierra County, California. Donor: Walter W. Bradley.

21398 GOLD (Au) crystallized with hessite (silver-gold telluride). From Bald Mountain, Brown's Flat, near Sonora, Tuolumne County, California. Donor: Walter W. Bradley.

21399 GOLD (Au) in crystals and plates. From 200-ft. level of Nigger Hill mine, near Jamestown, Tuolumne County, California. Donor: Walter W. Bradley.

21400 GOLD (Au) crystallized. From Davis mine, northeast of Placerville, El Dorado County, California. Donor: Walter W. Bradley.

21401 GOLD (Au). From Diltz mine, in Whitlock district, southwest of Mariposa, Mariposa County, California. Donor: Walter W. Bradley.

21402 GOLD (Au), crystallized. From Lazaro mine on Bald Mountain, near Sonora, Tuolumne County, California. Donor: Walter W. Bradley.

21403 GOLD (Au), crystallized. Donor: Walter W. Bradley.

21404 GOLD (Au), crystallized. From Mayflower mine, El Dorado County, California. Donor: Walter W. Bradley.

21405 MICROCLINE ($KAlSi_3O_8$) crystals with fluorite (CaF_2), quartz (SiO_2), and limonite ($Fe_2O_3\cdot nH_2O$). From Stove Mountain, El Paso County, Colorado. Donor: Edwin Over, 1951.

21406 MICROCLINE ($KAlSi_3O_8$) crystals with limonite ($Fe_2O_3\cdot nH_2O$) and albite ($NaAlSi_3O_8$). From Stove Mountain, El Paso County, Colorado. Donor: Edwin Over, 1951.

21407 PYROCHLORE ($NaCa(Cb,Ta_2)_6OF$) crystal in quartz (SiO_2). From Stove Mountain, El Paso County, Colorado. Donor: Edwin Over, 1951.

21408 ZIRCON ($ZrSiO_4$) crystals in granite. From St. Peter's Dome, El Paso County, Colorado. Donor: Edwin Over, 1951.

21409 ZIRCONIUM (Zr) metal and sponge. Produced by U. S. Bureau of Mines at Albany, Oregon. Donor: H. A. Doerner, U. S. Bureau of Mines, 1951.

21410 PYRITE (FeS_2) with quartz (SiO_2) crystals. From Frontino Gold Mines Ltd., Segovia, Colombia, South America. Donor: Samuel Altshuler, 1951.

21411 PYRITE (FeS_2) with galena (PbS), sphalerite (ZnS), and quartz (SiO_2). From Frontino Gold Mines Ltd., Segovia, Colombia, South America. Donor: Samuel Altshuler, 1951.

21412 CALCITE ($CaCO_3$) crystals on iron-stained quartz. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.

21413 STILBITE ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21414 STILBITE ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$), honey colored. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21415 STILBITE ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$), with calcite ($CaCo_3$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21416 STILBITE ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$), with calcite ($CaCo_3$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21417 STILBITE ($(Ca,Na,K)_6Al_{10}(Al,Si)_2Si_{28}O_{80}\cdot 30H_2O$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21418 LAUMONTITE ($(Ca,Na)_7Al_{12}(Al,Si)_2Si_{26}O_{80}\cdot 25H_2O$) and stilbite ($(Ca,Na,K)_6Al_{10}(Al,Si)_3Si_{28}O_{80}\cdot 30H_2O$) on quartz ($SiO_2$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21419 QUARTZ (SiO_2), smoky. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21420 QUARTZ (SiO_2), amethystine with hematite inclusions. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21421 PREHNITE ($H_2Ca_2Al_2Si_3O_{12}$) on calcite ($CaCO_3$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21422 HEULANDITE ($(Ca,Na,K)_6Al_{10}(Al,Si)Si_{29}O_{80}\cdot 25H_2O$) and amethystine quartz (SiO_2). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21423 CHABAZITE ($(Ca,Na,K)_7Al_{12}(Al,Si)_2Si_{26}O_{80}\cdot 40H_2O$) on amethystine quartz (SiO_2). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21424 QUARTZ (SiO_2), smoky and amethystine with coating of hematite. From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21425 QUARTZ (SiO_2), smoky and amethystine with calcite ($CaCO_3$) and heulandite ($(Ca,Na,K)_6Al_{10}(Al,Si)Si_{29}O_{80}\cdot 25H_2O$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.
21426 GMELINITE ($mNa_{12}Si_{28}Al_{12}O_{80}\cdot 40H_2O + nNa_{10}Ca_2Si_{26}Al_{14}O_{80}\cdot 40H_2O$) crystals on calcite ($CaCO_3$) and quartz ($SiO_2$). From Prospect Park, New Jersey. Donor: T. Orchard Lisle, 1951.

LIBRARY

Public Resources Code:

"2205. The State Mineralogist shall: . . .

(d) Provide a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the library of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes.

(f) Preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours.

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State to consist of such collections and library, and arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it."

Through the medium of the technical library, the services of the Division of Mines may be greatly extended. The value of a fine technical library kept up to date and made available to the public cannot be overestimated. The Division of Mines maintains such a library, particularly useful in helping to develop the mineral industry of California. It is planned to continue to improve the library by adding new books and arranging them in a manner most readily accessible to the staff and to the attendants who serve the public.

During the 1950-51 fiscal year 394 books were added to the library (290 by purchase, 29 by exchange, and 75 by donation) in contrast to 330 the previous year. The total number of classified books on hand in the library, June 30, 1951, was about 8,460. In addition, many volumes of serial publications, including U. S. government documents, publica-

tions from other states, and scientific periodicals were received and will be bound to form permanent library volumes. The list of books, given later in this report does not include these publications.

The books of the library are arranged on steel and wooden shelves in several adjoining halls and rooms. Duplicate copies of books are kept in storage rooms and used for exchange. Two reading rooms are maintained; one houses the scientific periodicals for technical research, and the other houses mining news publications and trade magazines for less technical reading. The latter is used continuously by the general public.

The Division of Mines subscribes to 39 periodicals for the San Francisco headquarters library and 11 for its branch offices. It also receives 40 periodicals on exchange. It received 152 separate maps and charts during the fiscal year.

The library is partly built up by exchange. The Division of Mines has established exchange of publications with 243 agencies; it also sends its publications without charge to 478 public libraries. Occasionally it borrows from or loans books to other libraries; during the fiscal year there were 14 incoming and 9 outgoing interlibrary loans.

The library serves as an information agency, not only by making its books available to the public and by providing other libraries with the publications of the Division of Mines, but it is active in the following ways: (1) By providing teachers' kits of maps, reports, circulars and catalogs useful in teaching; these are provided through cooperation with the Division of Conservation; (2) by maintaining a library of technical films (now 5 in number) plus others received on temporary loan and, upon request, having them shown to public gatherings—during the 1950-51 fiscal year there were 42 film loans, 32 film showings, and 2 films added to the library—*Miracle Flame* and *Man-Made Canyon;* (3) by the librarian making public appearances and attending conservation meetings, which numbered 13 during this fiscal year; (4) by providing references and reviews on current topics for publication in *Mineral Information Service.*

Books Added to the Library During Fiscal Year 1950-51
(D—Donation; E—Exchange)

Adams, Ansel, My camera in the national parks. Boston, Houghton Mifflin Co., 1950.

Adams, Ansel, My camera in Yosemite Valley. Boston, Houghton Mifflin Co., 1950.

(D) Agricola, Georgius, De re metallica trans. from the first Latin edition of 1556 by H. C. Hoover and L. H. Hoover. Dover Pub. New York, 1950.

Ahrens, L. H., Spectrochemical analysis. Cambridge, Mass., Addison Wesley Press, 1950.

American Association of Petroleum Geologists, Structure of typical American oil fields . . . vol. 2, 1929.

American Association of Petroleum Geologists, Structure of typical American oil fields . . . vol. 1, 1929.

American Association of Petroleum Geologists, Northern California group and Society of Economic Paleontologists and Mineralogists, Pacific Section annual spring field trip, May 12, 13, 1950. North Mt. Diablo monocline syllabus.

American Association of Petroleum Geologists, Possible future petroleum provinces of North America, 1951.

(D) American Bureau of Metal Statistics, Yearbook . . . 29th annual issue, 1949, New York, c. 1950.

American Institute of Mining and Metallurgical Engineers, Industrial minerals and rocks (nonmetallics other than fuels), 1949. 2 copies.

American Institute of Mining and Metallurgical Engineers, Ore deposits of the western states, 1933.

(D) American Institute of Mining and Metallurgical Engineers, Ore deposits of the western states, 1933.

(D) American Institute of Mining Engineers, General alphabetical and analytical index to the Transactions of the AIME, vols. 36-55 incl. (1905-1916), 1918.

American Institute of Mining Engineers, Trans., vol. 2, 12, 13, 14, 1873-74, 1883-84, 1885-86.

American Institute of Mining Engineers, Trans., vols. 5-10, May 1876-Feb. 1882, 1877?-1882.

(E) American Institute of Mining and Metallurgical Engineers, Transactions, vol. 117, Institute of metals division, 1935.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vols. 15, 78, 83, 87, 88, 94, 95, 101, 105, 116, 122, 1887-1936.

(E) American Institute of Mining and Metallurgical Engineers, Trans., vol. 126, Metal mining and mining geology, 1937.

American Institute of Mining and Metallurgical Engineers, Trans., vol. 133. Institute of metals, 1939.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 175, 176. Iron and steel division, 1948, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 178. Mining geology, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 180, Institute of metals division, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 181, Metal mining, industrial minerals, mineral industry education and geophysics, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 182, Extractive metallurgy division, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 183, Minerals beneficiation, 1949.

(D) American Institute of Mining and Metallurgical Engineers, Trans., vol. 184, Mining Branch, 1949, 1950.

(D) American Institute of Mining and Metallurgical Engineers, Statistics of oil and gas development and production (covering 1948), 1949.

American Petroleum Institute, Secondary recovery of oil in the United States, 2d ed. 1950.

American Philosophical Society, Proc., vol. 88, 1944.

American Society of Civil Engineers, Hydrology handbook, 1949.

(E) American Society for Testing Materials, Symposium on radiography . . . 1936, 1942, 1943.

American Society for Testing Materials, ASTM standards on mineral aggregates, concrete and nonbituminous highway materials, April 1950.

Anderson, B. W., Gem testing. Emerson Books, Inc., 1948.

(E) Anderson, Robert van Vleck, Geology in the coastal atlas of western Algeria. Geol. Soc. America Mem. 4, 1936, 2 copies.

Aries, Robert S., and Copulsky, William, The marketing of chemical products. Brooklyn, R. S. Aries & Assoc., c. 1948.

Austin, Mary, The land of little rain. Houghton-Mifflin Co., c. 1950.

N. W. Ayer & Sons directory of newspapers and periodicals, 1951.

Bailey, Gilbert E., Introduction to the soils of California. Los Angeles, Western Empire, c. 1913.

Bain, H. Foster, Types of ore deposits. Mining and Scientific Press, c. 1911.

Baker, Joseph E., ed., Past and present of Alameda County, California. Chicago, S. J. Clark Publ. Co. 1914. (2 vols.)

Bancroft, Hubert H., California pastoral, 1769-1848. Works, vol. 34, San Francisco, The History Co., 1888.

(D) Bangham, D. H., Progress in coal science. Interscience Publishers, 1950.

Barnhart, Clarence L., Thorndike-Barnhart comprehensive desk dictionary. Doubleday & Co., c. 1951.

Bartholomew, John, The advanced atlas of modern geography. McGraw-Hill Book Co., 1950.

(E) Barton, D. C., and Sawtelle, G., eds., Gulf coast oil fields, a symposium; 44 papers reprinted from Am. Assoc. Petroleum Geologists, Bull., 1936.

(E) Bassler, R. S., Faunal lists and descriptions of Paleozoic corals. Geol. Soc. America Mem., 1950.

(E) Bastin, Edson S., Interpretation of ore textures. Geol. Soc. America Mem. 1950.

Battelle Memorial Institute, Economics of fuel gas from coal, edited by J. F. Foster and R. J. Lund. McGraw-Hill Book Co., 1950.

Bekeart, Philip B., James Wilson Marshall, discoverer of gold . . . San Francisco, Society of Cailfornia Pioneers, 1924.

Berry, Edward Wilbur, Paleontology. Cambridge, Mass., Addison-Wesley Press, New York, McGraw-Hill Book Co., c. 1929.

(D) Bituminous Coal Institute, Bituminous coal annual, 1949.

Blumann, E., and Thomas, M. W., eds., California local history, a centennial bibliography. Stanford Univ. Press., 1950.

Boileau, J. T., A new and complete set of traverse tables . . . 15th ed. London, Jas. Nisbet & Co., 1912.

(E) Branner, John C., Syllabus of a course of lectures on economic geology. 3d ed., Stanford Univ., 1911.

(D) Branner, John C., Syllabus of a course of lectures on economic geology. 3d ed., Stanford Univ., 1911.

Brush, Geo. J., and Penfield, S. L., Manual of determinative mineralogy. 16th ed., John Wiley and Sons, c. 1898.

Bucher, Walter H., The deformation of the earth's crust. Princeton Univ. Press., 1933.

Buck, H. E., Crystal growth. John Wiley & Sons, 1951.

(D) California Corrugated Culvert Company, Handbook of water control. Berkeley, 1936.

California State Mining Bureau, Tenth annual report of the State Mineralogist for the year ending Dec. 1, 1890.

California State Mining Bureau, Twelfth report of the State Mineralogist (2d biennial), two years ending Sept. 15, 1894.

California State Mining Bureau, Fifteenth Report of the State Mineralogist, Mines and mineral resources of portions of California, 1919.

(E) California, University of, Institute of Transportation and Traffic Engineering, Selected logs of borings in the City and County of San Francisco. Ann Arbor, Edwards Bros., 1950. (2 copies.)

Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R., Internal structure of granitic pegmatites. Economic Geol., Monograph 2, 1949.

Canadian Institute of Mining and Metallurgy, Transactions, vol. 52, 1950.

Canadian Institute of Mining and Metallurgy, Transactions, vol. 53, 1951.

Canadian Mines Handbook, 1950. Toronto, Northern Miners Press, Ltd., 1950.

(D) Carnegie Institute of Washington Yearbook No. 25, July 1, 1925 to June 30, 1926.

(D) Carnegie Institute of Washington Yearbook No. 31, July 1, 1931 to June 30, 1932.

(D) Ceramic Industry, Ceramic materials issue, vol. 56, no. 1. Chicago, Industrial Publications, Inc., 1951.

Chevney, E. G., and Schantz-Hansen, T., This is our land. Minnesota Webb Book Publ., c. 1940.

Chicago Civil Defense Committee, Chicago alerts. 1951.

Cole, Grenville A. J., Outlines of mineralogy for geological students. London, Longmans, Green & Co. 1913.

Coleman, H. S.. Laboratory design. Reinhold Press, c. 1951.

Cooper, Herbert J., Scientific instruments II. Chem. Pub. Co., c. 1949.

Coxey, James R., Refractories. State College, Pennsylvania, Pennsylvania State College, 1950.

Coy, Owen C., Guide to the county archives of California. Sacramento, California Historical Survey Commission, 1919.

Crane, Walter R., Gold and silver. John Wiley & Sons, c. 1908.

Crook, Thomas, History of the theory of ore deposits. Thos. Murby & Co., 1933.

Curme, Geo. O., Principles and practice of English grammar. Barnes and Noble, c. 1947.

Cushman, Joseph A., Foraminifera—their classification and economic use. 4th ed., Harvard Univ. Press, c. 1948.

(D) Dallavalle, J. M., Micromeritics. 2d ed., Pitman Pub. Corp., c. 1948.

(D) Daly, R. A., Our mobile earth. Scribner's Sons, 1926.

Dammer, Bruno, and Tietze, Oskar, Nutzbaren mineralien, vols. 1 and 2. Verlag von Ferdinand Enke, Stuttgart, v. 1, c. 1913; v. 2, c. 1914.

Dana, Edward S., A textbook of mineralogy. 4th ed. rev. by Wm. E. Ford. John Wiley and Sons, 1932. 2 copies.

Davis, Lily M., Economic status of library personnel, 1949. Am. Library Assoc. 1950.

(D) Davis, Raymond E., Elementary plane surveying, 2d ed., McGraw-Hill Book Co., c. 1941.

(D) Davis, Raymond E., and Foote, Francis S., Surveying theory and practice. 3d ed., McGraw-Hill Book Co., c. 1940.

Davy, W. Myron, and Farnham, C. M., Microscopic examination of the ore minerals. McGraw-Hill Book Co., c. 1920.

DeMent, Jack, Handbook of fluorescent gems and minerals. Portland, Oregon, Mineralogist Publ. Co., 1949.

Dorr, John V. N., and Bosqui, Francis L., Cyanidation and concentration of gold and silver ores. 2d ed., McGraw-Hill Book Co., 1950.

(D) Douglas, Jack, Gold in placer, how to find it, how to get it. Dutch Flat, California, Jack Douglas, c. 1944.

(D) Douglas, Jack, and Mitchell, Harold, Gold in lode, how to find it, how to get it. Dutch Flat, California, Jack Douglas, 1949.

Dunkin, Paul Shaner, How to catalog a rare book. Am. Library Assoc., c. 1951.

Eardley, A. J., Structural geology of North America. Harper and Bros., c. 1951.

Eckwl, Edwin C., Building stones and clays. John Wiley and Sons, c. 1912.

The effects of atomic weapons prepared . . . under the direction of the Los Alamos Scientific Lab. Revised Sept. 1950. Gov't Printing Office, Sept. 1950.

Egloff, Gustav, Earth oil. Baltimore, Maryland, Williams and Wilkins, c. 1933.

Eitel, Wilhelm, Silicate melt equilibria. Rutgers Univ. Press, c. 1951.

Emerson, Frederick V., Agricultural geology, revised by John E. Smith. John Wiley and Sons, 1928.

Emmons, Wm. Harvey, Geology of petroleum. 2d ed., McGraw-Hill Book Co., c. 1931.

Emmons, Wm. Harvey, Geology of petroleum. 2d ed., McGraw-Hill Book Co., 1931.

Emmons, Wm. Harvey, The principles of economic geology. 2d ed., McGraw-Hill Book Co., 1940.

(E) Engineering and Mining Journal, Mine, mill, and smelter ideas that pay off.

Evans, Geo. W. B., Mexican gold trail—the journal of a forty-niner. San Marino, California, The Huntington Library, c. 1945.

(D) Fairbanks, Harold W., California . . . 6th ed., Harr Wagner Publ. Co., 1925.

Fairfield, Asa Merrill, Fairfield's pioneer history of Lassen County, California. San Francisco, H. S. Crocker Co., 1870.

Faith, W. L., Keyes, D. B. E., Clark, R. L., Industrial Chemicals. John Wiley and Sons, c. 1950.

Fearnsides, W. G., and Bulman, O. M. B., Geology in the service of man. Middlesex, England, Penguin Books, 1950.

Feipel, Louis N., and Browning, Earl W., Library binding manual. Am. Library Assoc., 1951.

Fenton, Carroll Lane, The world of fossils. Appleton-Century Co., c. 1933.

Field, Richard M., Natural resources of the U. S. Barnes & Noble, Inc. c. 1936.

Field, Richard M., An outline of the principles of geology. Barnes & Noble, Inc., c. 1934.

Finely, Ernest L., ed. History of Sonoma County. Press Democrat Publ., Santa Rosa, 1937.

Fowler, H. W., A dictionary of modern English usage. Oxford Univ. Press, London, 1937.

Fremont, John and Emory, W. H. Notes of travel in California . . . Jas. M'Glashan, Dublin, 1849.

Garfias, V. R., and Chapin, Theo. C., Geologea de Mexico, Editorial JUS, Mexico, 1949.

Garrels, Robert M., A textbook of geology. Harper & Bros., c. 1951.

Geikie, James, Earth sculpture. G. P. Putnam's Sons, c. 1898.

Geikie, James, Mountains, their origin, growth, and decay. Oliver and Boyd, Edinburgh, 1913.

(E) Geological Society of America, Application of geology to engineering practice. Berkey vol., 1950.

(E) Geological Society of America. Bibliography and index of geology exclusive of North America. Vol. 141, 1949.

(E) Geological Society of America, E. W. Scripps Cruise to the Gulf of California (5 parts). 1950.

(E) Geologischen Landesanstalten der Bundesrepublik Deutschland Geologisches Jahrbuch für die Jahre 1943-1948. Vol. 64, Amt. für Bodenforschung, Celle, Germany, 1950.

(D) George, Russell D., Minerals and rocks. D. Appleton-Century Co., c. 1943.

Glaessner, Martin F., Principles of micropaleontology. Melbourne Univ. Press, 1945.

Glover, Katherine, America begins again. McGraw-Hill Book Co., c. 1939.

(D) Goodyear, W. A., The coal mines of the western coast of the United States. A. L. Bancroft & Co., 1877.

Grabau, Amadeus W., A textbook of geology. Vol. 1, general geology; vol. 2, historical geology. D. C. Heath & Co. 1920, 1921.

Graves, Eileen C., ed., Ulrich's periodicals directory. 6th ed., R. R. Bowker Co., 1951.

Green, Will S., The history of Colusa County, California and general history of the state. Centennial Commemorative reprint edition. Willows, California, Elizabeth Eubank, 1950.

Gregory, Herbert E., ed., Military geology and topography . . . Yale Univ. Press, 1918.

Gregory, J. W., The elements of economic geology. E. P. Dutton & Co., 1927.

Guinn, J. M., History of the State of California and biographical record of coast counties, California. Chapman Publ. Co., c. 1902.

Guinn, J. M., History of the State of California and biographical record of Oakland and environs. Los Angeles Historic Record Co., c. 1907. (2 vols.)

Gunn, Douglas, Picturesque San Diego with historical and descriptive notes. Chicago, Knight & Leonard Co., 1887.

(D) Hager, Dorsey, Practical oil geology. 6th ed., McGraw-Hill Book Co., c. 1951.

Handbook of chemistry and physics . . . 32d ed., 1950-51. Cleveland Chemical Rubber Publ. c. 1950.

Harker, Alfred, Metamorphism. N. Y., E. P. Dutton & Co., 1939.

Harker, Alfred, Petrology for students. University Press, 1895.

(D) Harker, Alfred, Petrology for students. 5th ed., University Press, c. 1919.

Hartrampf, Gustavus A. Hartrampf's vocabulary-builder, revised and enlarged edition. N. Y., Grosset and Dunlap, c. 1936.

Harvey, Charles E., Spectrochemical procedures. Glendale, California. Applied Research Lab. c. 1950.

Hatch, F. H., An introduction to the study of ore deposits. London, Geo. Allen and Unwin, 1929.

Hatch, F. H., Wells, A. K., and M. K., The petrology of the igneous rocks. 10th ed., London, T. Murby & Co., 1949.

Hayes, C. W., Handbook for field geologists. 3d ed., revised and rearranged by Sidney Paige. N. Y., John Wiley and Sons, 1921.

Heizer, Robert F., ed. A manual of archaeological field methods, revised edition. Millbrae, California, The National Press, c. 1950.

(D) Hey, Max H., An index of mineral species and varieties arranged chemically. British Museum, 1950.

Hilgard, E. W., Soils. The Macmillan Co., c. 1906.

Hittell, John S., Mining in the Pacific states of North America. H. H. Bancroft & Co., 1861.

Hockheimer, M. F., and Diffor, J. W., eds. Educators guide to free films, 10th ed. 1950. Randolph, Wisconsin, Educators Progress Service, 1950.

Hodges, John C., Harbrace handbook of English. Harcourt Brace & Co., 1950.

Holmes, Arthur, The age of the earth. New York, Harper & Bros., 1927.

Honess, Arthur P., The nature, origin and interpretation of the etch figures on crystals. John Wiley & Sons, c. 1927.

Hoover, Theodore J., The economics of mining (non-ferrous metals). 3d ed., Stanford Univ. Press, 1948.

House, Homer C., and Harman, Susan Emolyn, Descriptive English grammar. 2d ed. Prentice-Hall, Inc., c. 1950.

Howe, J. Allen, The geology of building stones. London, Edward Arnold, 1910.

(E) Hulbert, Archer Butler, Forty-niners—the chronicle of the California trail. Little, Brown & Co., 1949.

Huntington, R. L., Natural gas and natural gasoline. McGraw-Hill Book Co., c. 1950.

Hutchinson, Lois I., Standard handbook for secretaries. 6th ed., McGraw-Hill Book Co., 1950.

Iddings, Joseph P., Igneous rocks. 2 vols., John Wiley & Sons, v. 1, c. 1909; v. 2, c. 1913.

Iddings, Joseph P., Rock minerals. John Wiley & Sons, c. 1906.

(D) Imperial Chemical Industries Ltd., Gold extraction for the small operator. 2d ed., London, 1936.

(D) Industrial Survey Associates, Placer County, its present and potential economic development. Auburn, California, Placer Co. Chamber of Commerce, 1951.

Ingersoll, L. A., Ingersoll's century annals of San Bernardino County, 1769-1904 . . . Los Angeles, L. A. Ingersoll, 1904.

Irving, Roland D., The copper-bearing rocks of Lake Superior. U. S. Geol. Survey Mon., 1883.

(E) Jagger, T. A., Abrasion hardness. Fifth Special Report of the Observatory of Hawaii, Hawaiian Volcano Research Assoc., 1950.

Jepson, Willis Linn, A manual of the flowering plants of California. Berkeley, Univ. California Press, 1951.

Jones, W. R., Minerals in industry. Middlesex, England, Penguin Books, 1950.

(D) Jones, W. R., and Williams, David, Minerals and mineral deposits. London, Oxford Univ. Press, 1948.

(E) King, Clarence, Geological and topographical atlas accompanying the report of the geological exploration of the 40th parallel. Engineering Dept., U. S. Army, 1876.

Knowland, Joseph R., California, a landmark history; story of the preservation and marking of early day shrines. Oakland Tribune, c. 1941.

Krumbein, W. C., and Pettijohn, F. J., Manual of sedimentary petrography. Appleton-Century-Crofts, c. 1938.

Krumbein, W. C., and Sloss, L. L., Stratigraphy and sedimentation. San Francisco, W. H. Freeman & Co., 1951.

(D) Kuenen, Ph. H., Marine geology. John Wiley & Sons, c. 1950.

Ladoo, R. B., and Myers, W. M., Nonmetallic minerals. 2d ed., McGraw-Hill Book Co., 1951.

Lakes, Arthur, Geology of western ore deposits, new edition. (2d ed.) Denver, Kendrick Book and Stationery Co., 1905.

Landes, Kenneth K., Petroleum geology. John Wiley & Sons, c. 1951.

Landes, Kenneth K., Physical geology and man. N. Y., Prentice-Hall Co., c. 1948.

Leith, C. K., The economic aspects of geology. Constable & Co., Ltd., 1922.

Leith, C. K., Elements of a national mineral policy. Am. Inst. Min. Met. Eng., c. 1933.

LeRoy, L. W., ed. Subsurface geologic methods (a symposium) 2d ed. Colorado School of Mines, 1950.

Letiche, J. M., Reciprocal trade agreements in the world economy. N. Y. Kings Crown Press, 1948.

(D) Lewis, J. V., and Hawkins, A. C., A manual of determinative mineralogy with tables . . . 4th ed. John Wiley and Sons, 1931.

Liddell, Donald M., ed., Handbook of nonferrous metallurgy; I., Principles and processes; II, Recovery of the metals, 2d ed. McGraw-Hill Book Co., 1945. (2 vols.)

(D) Lightfoot, William Ewart, A study of hydraulic-filling in metal mines. Thesis, B. S., Mining Engineering, Univ. Washington. 1950.

Lilley, Ernest R., Economic geology of mineral deposits. Henry Holt & Co. c. 1936.

Long, Mason, The new college grammar. New York, Ronald Press Co., c. 1935.

Longbridge, C. C., Hydraulic mining. London, The Mining Journal, 1910.

Loomis, F. B., Field book of common rocks and minerals. New York, G. P. Putnam's Sons, c. 1923.

Ludwick, M. T., compiler, Indium . . . New York, Indium Corp. of America, c. 1950.

Lyon, T. Lyttleton, and Buckman, H. O., The nature and properties of the soils. N. Y., The Macmillan Co., c. 1929.

McCulloch, Hugh, The Mariposa estate: its past, present, and future. New York, Russells' Am. Steam Printing House, 1868.

McGroarty, John S., History of Los Angeles County. Chicago and New York, Am. Hist. Soc. Inc., 1923. (3 vols.)

MacLean, Alexander, Geology for the layman. Toronto, Canada, Northern Miner, 1939.

(D) Matthes, Francois E., The incomparable valley. Berkeley, Univ. California Press. 1950.

(D) Matthes, Francois E., Sequoia National Park, a geological album. Berkeley, Univ. California Press, c. 1950.

(D) Matthewson, C. H., ed. Modern uses of non-ferrous metals. Am. Inst. Min. and Met. Eng., c. 1935.

A memorial and biographical history of northern California, illus. Chicago, The Lewis Publ. Co., 1891.

Merrill, Geo. P., A treatise on rocks, rock-weathering and soils. London, Macmillan Co., 1906.

Michell, F. B., The practice of mineral dressing. London, Mine and Quarry Eng. Electrical Press, 1950.

Middlemiss, Ross R., Analytic geometry. McGraw-Hill Book Co., 1945.

Miers, Harry A., Mineralogy—an introduction to the scientific study of minerals. Macmillan and Co., 1902.

Mills, Enos A., Romance of geology. Boston, Houghton Mifflin Co., c. 1926.

Mines Handbook . . . by Walter H. Weed, vols. 12, 13, 16. New York, Stevens Copper Handbook Co., 3 vols. 1916, 1918, 1925.

Mining World, Mine Development and directory number, vol. 13 no. 5, April 15, 1951. San Francisco, Min. World, 1951. (2 copies).

Moore, W. G., A dictionary of geography. Hammondsworth, England, Penguin Books, Ltd., 1949.

Moulton, Forest R., ed., The world and man as science sees them. N. Y., Literary Guild of America, 1937.

Muir, John, The Yosemite. New York, The Century Co., 1912.

(D) Munger Oilogram, Annual report, 1950. Los Angeles, Munger Oilogram, 1951.

National Research Council. Handbook of scientific and technical societies and institutions of the United States and Canada, 5th ed. Washington, D. C., Nat. Res. Council, April 1948.

Nevada, a guide to the silver state, compiled by workers of the Writer's Program, Works Projects Administration, Portland, Am. Guide Ser. Binsords and Mort., c. 1940.

(E) Nevada City Nugget, "100" years of Nevada County. Supplement to Nevada City Nugget, vol. 26, no. 20, May 18, 1951.

Nevin, Chas. M., Principles of structural geology, 4th ed., New York, John Wiley and Sons, c. 1949.

(D) Nevin, Chas. M., Principles of structural geology. New York. John Wiley and Sons, 1931.

(D) Newton, Joseph, An introduction to metallurgy. 2d ed., New York, John Wiley and Sons, c. 1947.

Niggli, Paul, Ore deposits of magmatic origin. London, Thos. Murby & Co., 1929.

Oil and Gas Journal, Tulsa, Oklahoma, Fifty years of oil in the southwest. Golden anniversary number, May 1951. Supplement to Oil and Gas Journal, vol. 50, no. 4, May 31, 1951. Tulsa, Petroleum Publ. Co., 1951.

Oregon, end of the trail. Compiled by Workers of the Writers' Program, Works Projects Administration. Am. Guide Ser. Binfords and Mort. Portland. c. 1940.

Palache, Chas., Berman, H., and Frindel, C., The system of mineralogy of J. D. Dana, etc. 7th ed., vol. 1, Elements, sulfides, sulfosalts, oxides. John Wiley and Sons, c. 1944.

Palmer, Lyman L., History of Napa and Lake Counties, California . . . San Francisco, Slocum Bowen and Co., 1881.

Panyity, L. S., Prospecting for oil and gas. New York, John Wiley & Sons, c. 1920.

(D) Parsons, A. B., Seventy-five years of progress in the mineral industry, 1871-1946. Am. Inst. Min. Met. Eng., c. 1948.

Patterson's American educational directory, vol. 48. Chicago, Field Enterprises, Inc., c. 1951.

Pearl, Richard M., Guide to geologic literature. McGraw-Hill Book Co., 1951.

Perry, John H., ed., Chemical engineers' handbook, 3d ed., McGraw-Hill Book Co., 1950.

Petroleum World annual review, 18th ed., 1950. Los Angeles, Mona Palmer, c. 1950. (3 copies).

Phillips, J. Arthur, The mining and metallurgy of gold and silver. London, E. and F. N. Soon, 1867.

(D) Pirson, Sylvain J., Elements of oil reservoir engineering. McGraw-Hill Book Co., c. 1950.

(D) Pirsson, Louis V., Rocks and rock minerals. 3d ed., revised by Adolph Knopf. John Wiley & Sons, c. 1947.

(E) Pit and quarry handbook and directory of the nonmetallic minerals industries. 43d ed. Chicago, Complete Serv. Publ. Co., 1950.

Pratt, W. E., and Good, D., eds., World geography of petroleum. Am. Geog. Soc., New York. c. 1950.

Rait, J. R., Basic refractories. Interscience Publ. Co., 1950.

Rajgarhia, Chand Mull., Mining, processing, and uses of Indian mica. McGraw-Hill Book Co., c. 1951.

Rastall, R. H., Lake and Rastall's textbook of geology, revised by R. H. Rastall. 5th ed., London, Edward Arnold & Co., 1947.

Reed, Ralph D., Geology of California. London, Thos. Murby & Co., c. 1933.

Reed, W. M., The earth for Sam. Harcourt, Brace & Co., New York. c. 1929.

Reed, W. Maxwell, America's treasure. Harcourt, Brace & Co. New York, c. 1939.

Rice, C. M., Dictionary of geological terms. . . . Ann Arbor, Edwards Bros., 1949. (2 copies).

Rice, C. M., Dictionary of geological terms. . . . Ann Arbor, Edwards Bros., 1950.

Ries, H., Economic geology. 7th ed., John Wiley and Sons, 1937.

Risdon Iron Works, San Francisco, Catalogs 1897-1906.

(D) Roberts, A., Geological structures and maps. Sir Isaac Pitman & Sons, 1947.

Rodale, J. I., ed., The word finder. Emmanus, Pa., Rodale Press, c. 1947. (2 copies).

Rogers, Austin F., Introduction to the study of minerals, 3d ed., McGraw-Hill Book Co., 1933.

Rosenthal, Ernst, Pottery and ceramics. Penguin Books, 1949.

Rowe, Jesse Perry, Practical mineralogy simplified. John Wiley & Sons, c. 1911.

Runner, D. G., Geology for civil engineers. Chicago, Gillette Publ. Co., c. 1939.

Russell, Carl P., Early mining excitements east of Yosemite. Reprinted from Sierra Club Bulletin, Annual Number, 1928.

Russell, Israel C., Lakes of North America. Boston, Ginn & Co., c. 1895.

Russell, Israel C., Rivers of North America. G. P. Putnam's Sons, c. 1898.

Russell, Ralston, Jr., The electrical and technical ceramic industry of Germany. N. Y., Mapleton House, 1947.

Rutley, Frank, The study of rocks, 5th ed., London, Longmans, Green & Co., 1891.

Sander, Bruno, Contributions to the study of depositional fabrics, transl. by Eleanora B. Knopf. Am. Assoc. Petroleum Geologists, 1951.

(D) Savage, Eros M., Prospecting for gold and silver. McGraw-Hill Book Co., c. 1934.

Schenck, H. G., and Keen, A. M., California fossils for the field geologist. Stanford Univ. Press, c. 1950.

Schuchert, Chas. and LeVene, C. M., The earth and its rhythms. New York, D. Appleton & Co., c. 1927.

Scott, William Berryman, An introduction to geology. 2 vols, vol. 1, Physical; vol. 2, Historical. 3d ed., New York, The Macmillan Co., c. 1932.

Searle, Alfred B., The clayworkers handbook. 5th ed., London, Chas. Griffin, 1949.

Searle, Alfred B., Refractories for furnaces, kilns, retorts, etc. 2d ed., London, Crosby, Lockwood & Son, Ltd., 1948.

Seyler, Clarence A., The microscopical examination of coal. London, His Majesty's Stat. Ofc., 1929.

Shand, S. J., The study of rocks. 2d ed., London, T. Murby & Co., 1947.

Shimer, Hervey Woodburn, An introduction to earth history. Boston, Ginn & Co., c. 1925.

Shimer, Hervey W., An introduction to the study of fossils. The Macmillan Co., c. 1914.

Simonin, L., Underground life; or mines and miners, translated, adapted to the present state of Brit. mining, and ed. by H. W. Bristow. New York, D. Appleton & Co., 1869.

Singer, T. E. R., German-English dictionary of metallurgy. McGraw-Hill Book Co., c. 1945.

(E) Smithsonian Institution, Annual report . . . of the Smithsonian Institution for the year ended June 30, 1949. Washington, D. C., 1950.

Smythe, William E., History of San Diego . . . vol. 1, Old town. San Diego, The History Co., 1908.

Spears, John R., Illustrated sketches of Death Valley and other borax deserts of the Pacific Coast. Rand McNally Co., c. 1892.

Stanier, William, ed., Plant engineering handbook. McGraw-Hill Book Co., c. 1950.

Stansfield, John. Assimilation and petrogenesis. Urbana, Ill., Valley Publ. Co., c. 1928.

Studies in petrology and mineralogy dedicated to Esper S. Larsen, Jr. . . . by friends and former students. Am. Mineralogist, Spec. Number, 1950.

(D) Taggert, Arthur F., Elements of ore dressing. John Wiley & Sons, c. 1951.

Tarr, Ralph S., College physiography. New York, The Macmillan Co., 1924.

Tarr, Ralph S., and von Engeln, O. D., New physical geography. Revised ed., The Macmillan Co., c. 1926.

(D) Tracy, John C., Surveying theory and practice. John Wiley & Sons, c. 1947.

Trask, Parker D., Origin and environment of source sediments of petroleum. Houston, Texas, Gulf Publ. Co., c. 1932.

Trask, Parker D., and Petnode, H. W., Source beds of petroleum. Tulsa, Am. Assoc. Petroleum Geologists, c. 1942.

Turner, Francis J., and Verhoogen, Jean, Igneous and metamorphic petrology. McGraw-Hill Book Co., c. 1951, (2 copies).

Tyrrell, G. W., The principles of petrology. 2d ed. Methuen & Co., Ltd., 1929.

Tuolumne County, California . . . an exposition of its resources and possibilities. Sonora, Union Democrat, c. 1909.

Tupholme, C. H. S., Photography in engineering. New York, Chem. Publ. Co., c. 1949.

Twenhofel, W. H., Principles of sedimentation. McGraw-Hill Book Co., 2d ed., 1950.

(D) Tyrrell, G. W., The principles of petrology. 2d ed., New York, E. P. Dutton and Co., 1929.

Tyson, Philip T., Geology and industrial resources of California. Baltimore, Minifie & Company, 1851.

Umbgrove, J. H. F., The pulse of the earth. 2d ed., The Hague, M. Nijhoff, 1947.

(D) U. S. Department of Agriculture, Atlas of American agriculture. Physical basis including land relief, climate, soils and national vegetation of the United States, 1936.

(D) U. S. Department of Agriculture, Climate and man. Yearbook of Agriculture, 1941.

U. S. Bureau of Mines, Minerals Yearbook, 1948. U. S. Gov't Printing Office, 1950, (4 copies).

(E) U. S. Coast and Geodetic Survey, Hydrographic manual. Rev. (1942) ed., corrected and repr., 1946. Spec. Pub. 143, 1946.

(D) U. S. Congress, House Com. Pub. Lands, Conference on revision of U. S. mining laws; hearing before sub-com. 81st Cong. 1st sess. Oct. 17, 18, 1949; ser. 24, U. S. Gov't Printing Office, 1950.

(D) U. S. Forest Service, Woody-plant seed manual. Misc. Pub. 654. June 1948.

(D) U. S. General Land Office, Standard field tables and trigonometric formulas. 6th ed., 1942.

(D) U. S. General Land Office, Restoration of lost or obliterated corners and subdivision of sections . . . U. S. Gov't, 1939.

U. S. Government Printing Office, Theory and practice of bookbinding. 1950.

U. S. Government Printing Office, Theory and practice of presswork. 1948.

(D) U. S. President's water resources policy commission, 1950. A water policy for the American people, summary of recommendations from the report of the Commission. Washington, D. C., 1950.

U. S. President's water resources policy commission, 1950. Report, vol. 3, Water Resources law. Gov't Printing Office, 1950.

U. S. President's water resources policy commission, 1950, Report, vol. 2, Ten rivers in America's future. U. S. Gov't Printing Office, 1950.

U. S. President's water resources policy commission, 1950, Report, vol. 1. A water policy for the American people. U. S. Gov't Printing Office, 1950.

(D) U. S. Soil Conservation Service, Annotated bibliography on sedimentation . . . Gov't Printing Office, 1950.

(D) U. S. Tariff Commission, U. S. import duties (1950) . . . U. S. Gov't Printing Office, 1950.

Uren, Lester C., Petroleum production engineering; petroleum production economics, McGraw-Hill Book Co., 1950.

Van Bemmelen, R. W., The geology of Indonesia. Vol. 1A, Gen. geol. of Indon.; vol. 1B, Portfolio; vol. 2, Econ. geology. The Hague, Gov't Print. Office, M. Jijhoff, sole agent. 1949, (3 volumes.)

van der Veen, R. W., Mineragraphy and ore-deposition, vol. 1. The Hague, G. Naeff, 1925.

Velasquez de la Cadena, Mariano, A new pronouncing dictionary of the Spanish and English languages. Chicago, Wilcox & Follett, 1948.

von Bernewitz, M. W., Handbook for prospectors and operators of small mines, 4th ed., McGraw-Hill Book Co., 1943. 2 copies.

von Engeln, O. D. Geomorphology, systematic and regional. N. Y. The Macmillan Co., 1949.

Von Vega, Baron, Logarithmic tables of numbers and trigonometrical functions . . . stereotyped. 85th ed. (trans. from 40th ed. by Bremiker). Van Nostrand. Post-1856?

Voskuil, Walter H., Minerals in modern industry. John Wiley and Sons, c. 1930.

(D) Wahlstrom, Ernest E., Optical crystallography. 2d ed., John Wiley and Sons, 1951.

Watkins, Rolin C., ed., History of Monterey and Santa Cruz Counties, California. Chicago, S. J. Clarke Publ. Co., 1925, (2 volumes).

Webster's new international dictionary of the English language, 2d ed. unabridged, India paper. 2d ed., Springfield, Mass., G. and C. Merriam Co., 1950.

. . . Webster's new collegiate dictionary. Springfield, Mass., G. and C. Merriam Co., c. 1949, (3 copies).

Weston, Edward, My camera on Pt. Lobos. Boston, Houghton Mifflin, 1950.

(D) Whitmore, Geo. D., Advanced surveying and mapping. Scranton, Pa., International Textbook Co., c. 1949.

(D) Wickenden, William E., A professional guide for junior engineers. New York, Engineers' Council for Professional Development, c. 1949.

Willcox, R. N., Reminiscences of California life. Printed by author, Avery, Ohio, 1897.

(E) Williams, A. F., The genesis of the diamond. Vol. I, and vol. II. London, Ernest Benn, Ltd., 1932, (2 vols.).

(E) Williams, A. F., Some dreams come true. Cape Town, S. Africa, Howard B. Timmins, 1948.

Williams, Archibald, The romance of modern mining. London, Seeley & Co., Ltd., 1907.

Winchell, A. N., and Horace, Elements of optical mineralogy . . . Pt. 2, Descriptions of minerals. 4th ed., John Wiley and Sons, c. 1951.

Wormington, H. M., Ancient man in North America. 3d ed., (Pop. series No. 4) Denver Museum of National History, 1949.

Wrather, W. E., and Lahee, F. H., eds., Problems of petroleum geology . . . Am. Assoc. Petroleum Geologists, 1934.

Zimmerman, Erich, W., World resources and industries. New York, Harper & Bros., c. 1951.

Zittel, Karl A., Grudzuge der paleontologie. I. Abteilung: Invertebrata. II. Abteilung: Vertebrata. Berlin, Druck und verlag von R. Oldenbourg. 1923, 1924, (2 vols.).

PUBLICATIONS BY THE DIVISION OF MINES

Public Resources Code:

"2205. The State Mineralogist shall: . . . (h) Issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this State."

"2209. The State Mineralogist may fix a price upon and dispose of to the public all publications of the division, including reports, bulletins, maps, registers, or other publications. The price shall approximate the cost of publication and distribution. He may also furnish the publications of the division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies.

"2210. All money received by the division from sales of publications issued by the division shall be deposited at least once each month in the State Treasury to the credit of the General Fund . . ."

Four types of publications are issued by the Division of Mines. All except *Mineral Information Service* (sent gratis) are sold to the public at cost of printing. During fiscal 1950-51, \$18,687.15 was received from sales of publications.

(1) *Mineral Information Service.* Monthly 8-page ($8\frac{1}{2}'' \times 11''$) offset press pamphlet, distributed without cost upon request.

Through this medium, current information and news of mineral developments are given, statistics and markets are recorded without delay, announcement of new publications permits wider distribution of results of surveys, and a regular mineral commodity study of great interest to the public is reported. New industries have actually been initiated by this service. This circular has been well received and is distributed to more than 13,000 persons, more than 10,000 of whom are on the regular mailing list.

(2) *California Journal of Mines and Geology.* Quarterly periodical (paper covered, $6'' \times 9''$) sold separately (\$1.00) or by annual subscription (\$3.00). Through the medium of the Journal, an inventory of the

mines of the state is recorded. County reports on the mines and mineral resources, reports on market surveys, final statistical figures, and the annual report of the State Mineralogist are published in the Journal. Each county report is accompanied by a tabulated list of mining properties which is coordinated with a mineral map. In this manner the Division maintains a directory of all mines and significant properties of California.

(3) *Bulletins.* Published at irregular intervals (generally cloth covered, standard format 6″ x 9″, but other sizes also used); cover state-wide surveys, broad-subject monographs, and quadrangle geologic surveys; sold at cost of printing.

Such well-known publications as Bulletin 141, Guidebook of the Mother Lode country; Bulletin 144, Copper in California; Bulletin 150, Geology of southwestern Santa Barbara County; Bulletin 155, Minerals useful to California agriculture; and Bulletin 156, Mineral commodities of California, have been issued in this series. This type of publication lends itself well to multiple authorship, and serves as a reference book to investors and prospective operators as well as a source of coordinated data.

(4) *Special Reports.* A new series (paper-covered, 8½″ x 11″) covering subjects of special concern but not of state-wide scope, or of as broad scope as the bulletin.

Through the medium of the special report the results of units of research are available without much delay. The 8½″ x 11″ page provides more ample room for tables, photographs, and maps than the standard Journal and Bulletin 6″ x 9″ page. The special report is increasing in popularity, and has relieved the overloading of the Journal with highly technical reports.

Some particularly popular publications issued recently by the Division include:

Bulletin 156, *Mineral commodities of California*
Bulletin 155, *Minerals useful to California agriculture*
Bulletin 150, *Geology of southwestern Santa Barbara County, California*
Bulletin 141, *Geologic guidebook along Highway 49—Sierran gold belt—the Mother Lode country.*
Bulletin 118, *Geologic formations and economic development of the oil and gas fields of California*
State Geologic Map of 1938, *Geologic map of California*
January 1951 California Journal of Mines and Geology containing report *Mines and mineral resources of Inyo County*
Separate, *Manner of locating and holding mineral claims in California*
October 1949 California Journal of Mines and Geology supplement—*The elephant as they saw it.*
Special Report 6, *Geology of Bitterwater Creek*
Special Report 10-A, *Nephrite jade and associated rocks of the Cape San Martin region, Monterey County, California.*
Special Report 10-B, *Nephrite in Marin County, California*
Special Report 10-C, *Jadeite of San Benito County, California*
Mineral Information Service

The following list gives the titles of publications credited to the Division of Mines for fiscal 1950-51. The list is divided into two parts as follows:

(1) Published—Actually distributed to the public.

(2) In press—Not ready for distribution on June 30, 1951, but in process of publication.

Since the authorship of reports is not limited to the staff of the Division of Mines, the affiliation of each author is shown by convenient symbols as follows:

BM	Member of U.S. Bureau of Mines
BR	Member of U.S. Bureau of Reclamation
C	Consultant or member of commercial firm
CAS	Member of California Academy of Sciences
GS	Member of U.S. Geological Survey
SBC	Member of State Bureau of Chemistry
SDM	Member of State Division of Mines
SI	Member of Smithsonian Institution
SWR	Member of State Division of Water Resources

REPORTS PUBLISHED BY THE DIVISION OF MINES FISCAL 1950-51

MINERAL INFORMATION SERVICE

Vol. 3, no. 7: Mine production by counties, 1949 (gold, silver, copper, lead, zinc); Abrasives; Price list of available Division of Mines publications.
8: Cobalt.
9: Strategic minerals in California and the stockpiling program; Asbestos.
10: Sources of information on strategic minerals.
11: Mercury; Index to quadrangle geologic mapping in California.
12: Salt, soda ash, and salt cake.

Vol. 4, no. 1: Need for marketing information on California minerals; Mineral needs and problems of the bituminous base roofing industry; Index to Mineral Information Service, vol. 3 (1950).
2: Annual statistical issue (mineral production by counties, 1949).
3: Lithium; circularization announcement; mineral marketing information.
4: Perlite industry in Los Angeles area; mineral marketing information.
5: Niobium and tantalum in modern industry.
6: Asbestos; mercury mining in Mayacmas district; commercial minerals of California (table).

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

Vol. 46, No. 3, July 1950, containing: Needles magnesite deposit, San Bernardino County, California, by Charles J. Vitaliano (GS); Northern California, as a market for chemicals, E. William Eipper, editor (C); Skaggs Springs quicksilver mine, Sonoma County, California, by Donald L. Everhart (GS); The Altoona quicksilver mine, Trinity County, California, by C. Melvin Swinney (GS); Health and Safety work of the Bureau of Mines, by James Boyd (BM); Mines and mineral resources of Yolo County, by J.C. O'Brien (SDM).

Vol. 46, No. 4, October 1950, containing: Mines and mineral resources of Madera County, California, by C. A. Logan (SDM); Mining law in recent years, by William E. Colby (C); Quicksilver deposits of the Cachuma district, Santa Barbara County, California, by Donald L. Everhart (GS); Index to volume 46.

Vol. 47, No. 1, January 1951, containing: Limestone in the California beet sugar industry, by F. H. Ballou Jr. (C); Mines and mineral resources of Inyo County, by L. A. Norman Jr. and Richard M. Stewart (SDM).

Vol. 47, No. 2, April 1951, containing: Annual report of the State Mineralogist, Chief of the Division of Mines, for the 101st fiscal year, by Olaf P. Jenkins (SDM); Counties of California—mineral production and significant mining activities of 1949, prepared under the direction of Charles V. Averill and L. A. Norman Jr. (SDM); Publications of the California State Division of Mines to March 1, 1951 (SDM).

BULLETINS

134. Part 1, Chapter 2, Chromite deposits of Siskiyou County, California, by Francis G. Wells and Fred W. Cater Jr. (GS).
150. Geology of southwestern Santa Barbara County, California—Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota quadrangles, by T. W. Dibblee Jr. (C).
153. Geology and Mineral resources of the Neenach quadrangle, California, by John H. Wiese (C).
155. Minerals useful to California agriculture, containing: Exploring the soils of California, by Hans Jenny and collaborators (U); Commercial fertilizers, by William E. Ver Planck (SDM); Minerals of commercial fertilizers, by William E. Ver Planck (SDM); Agricultural minerals in California, by Robert Z. Rollins (SBC); Agricultural gypsum, by Robert Z. Rollins (SBC); Gypsum resources of California, by William E. Ver Planck (SDM); Limestone marl resources of California, by Oliver E. Bowen Jr. (SDM); California sources of sulfur and sulfuric acid, by James W. Vernon (SDM); California's resources of the minerals of minor agricultural use, by Lauren A. Wright (SDM).
156. Mineral commodities of California—geologic occurrence, economic development, and utilization of the state's mineral resources, prepared by the Staff of the Division of Mines (SDM).
157. Geology of the San Jose-Mount Hamilton area, California, by Max D. Crittenden Jr. (U).

SPECIAL REPORTS

1-A. Sierra Blanca limestone in Santa Barbara County, California, by George W. Walker (GS)
1-B. The Calera limestone, San Mateo and Santa Clara Counties, California, by George W. Walker (GS)
2. Geology of part of the Delta-Mendota Canal near Tracy, California, by Parry Reiche (BR)
3. Commercial "black granite" of San Diego County, California, by Richard A. Hoppin and L. A. Norman Jr. (U, SDM)
4. Geology of the San Dieguito pyrophyllite area, San Diego County, California, by Richard H. Jahns and John F. Lance (U)
5. Geology of the Jurupa Mountains, San Bernardino and Riverside Counties, California, by Edward M. MacKevett (U)
6. Geology of Bitterwater Creek area, Kern County, California, by Henry H. Heikkila and George M. MacLeod (U)
10-A. Nephrite jade and associated rocks of the Cape San Martin region, Monterey County, California, by Richard A. Crippen Jr. (SDM)

REPORTS IN PRESS
CLOSE OF FISCAL 1950-51

MINERAL INFORMATION SERVICE

Vol. 4, no. 6: Fluorescence of minerals; Price list of available publications of the Division of Mines.

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

Vol. 47, no. 3, July 1951, containing: Mineral needs and problems of the bituminous base roofing industry, by Dozier Finley (C); Mines and mineral resources of Fresno County, California, by C. A. Logan, Lewis T. Braun, and James W. Vernon (SDM)

Vol. 47, no. 4, October 1951, containing: Mines and mineral resources of Contra Costa County, California, by Fenelon F. Davis and James W. Vernon (SDM); Fluorspar in California, by James W. Crosby III and Samuel R. Hoffman (SDM)

BULLETINS

134. Part 3, Chapter 4, Chromite deposits of El Dorado County, California, by Fred W. Cater Jr., Garn A. Rynearson, and Donald H. Dow (GS)

154. Geologic guidebook of the San Francisco Bay counties, containing: Opening of the Golden Gate, by Dorothy G. Jenkins (C); Place names in the San Francisco Bay counties, by Erwin G. Gudde (U); Indians of the San Francisco Bay area, by Robert F. Heizer (U); Adobe houses in the San Francisco Bay region, by J. N. Bowman (C); Old lime kilns near Olema, by Adan E. Treganza (U); Geologic history of San Francisco Bay, by George D. Louderback (U); Development of the landscape of the San Francisco Bay counties, by Arthur D. Howard (U); History of geologic investigation in the bay region, by V. L. VanderHoof (U); Geology of the San Francisco Bay counties; by N. L. Taliaferro (U); History of earthquakes in the San Francisco Bay area, by Perry Byerly (U); Geologic map of the San Francisco Bay region, by Oliver E. Bowen Jr. and Richard A. Crippen Jr. (SDM); Prehistoric land animals of the San Francisco Bay region, by R. A. Stirton (U); Invertebrate fossils and fossil localities in the San Francisco Bay area, by Leo G. Hertlein (CAS); Prehistoric forests of the San Francisco Bay area, by Ralph W. Chaney (U); California's contribution of mineral raw material to San Francisco industries, by Lauren A. Wright (SDM); Utilization of minerals of the San Francisco Bay counties, by Charles V. Averill (SDM); Salines in the bay area, by William E. Ver Planck Jr. (SDM); Mineral fuels of the San Francisco Bay counties, by Gordon B. Oakeshott (SDM); Limestone and the cement industry of the San Francisco Bay counties, by Oliver E. Bowen Jr. (SDM); Building stone and aggregate industry of the San Francisco Bay counties, by Mort D. Turner (SDM); Volcanic rocks useful in the San Francisco Bay area, by Charles W. Chesterman (SDM); Clay and the ceramic industry of the San Francisco Bay counties, by Mort D. Turner (SDM); Ceramic education and industries in the San Francisco Bay area, by Joseph Pask (U); Manganese and quicksilver mineralization in the San Francisco Bay region, by Oliver E. Bowen Jr. (SDM); The New Almaden quicksilver mines, by Edgar H. Bailey (GS); Serpentine and chromite deposits of the San Francisco Bay counties, by Francis G. Wells (GS); Magnesite mineralization in the Red Mountain district, by Alfred J. Bodenlos (GS); Diatom deposits, by G. Dallas Hanna (CAS); Surface water supplies in the San Francisco Bay area, by Robert Wing (SWR); Geology of the Farallon Islands, by G. Dallas Hanna (CAS); Unusual minerals of the bay area, by Richard A. Crippen Jr. (SDM); Highways and byways of particular geologic interest, by Oliver E. Bowen Jr. (SDM)

158. Evolution of California's landscape, by N. E. A. Hinds (U)

159. Crystalline rocks of southwestern California, containing: Geology of the Corona, Elsinore, and San Luis Rey quadrangles of southern California by E. S. Larsen (U); Geology of Cuyama Peak quadrangle, by Donald L. Everhart (U); Occurrence of ground water in bedrock in western San Diego County, by Richard Merriam (U)

160. Geology of Saltdale quadrangle, Kern County, California, by T. W. Dibblee Jr. (C)

161. Geology of Healdsburg quadrangle, containing: Geology of Healdsburg quadrangle, California, by William K. Gealey (U); Mineralogy of the California glaucophane schists, by George Switzer (SI)

SPECIAL REPORTS

7-A. Gem- and lithium-bearing pegmatites of the Pala district, San Diego County, County, California, by Richard H. Jahns and Lauren A. Wright (U, SDM)

7-B. Economic geology of the Rincon pegmatites, San Diego County, California, by John B. Hanley (GS)

8. Talc deposits of steatite grade, Inyo County, California, by Ben M. Page (GS)

9. Type Moreno formation and overlying Eocene strata on the west side of the San Joaquin Valley, Fresno and Merced Counties, by Max B. Payne (C)

10-B. Nephrite in Marin County, California, by Charles W. Chesterman (SDM)

10-C. Jadeite of San Benito County, California, by H. S. Yoder and Charles W. Chesterman (C, SDM)

11. Guide to geology of Pfeiffer Big Sur State Park, California, by Gordon B. Oakeshott (SDM)

12. Hydraulic filling in metal mines, by William Ewart Lightfoot (U)

13. Geology of the saline deposits in Bristol Dry Lake near Amboy, San Bernardino County, California, by Hoyt S. Gale (GS)

ORE BUYERS' LICENSES AND INSPECTION

Public Resources Code:

"2250. It is unlawful for any person to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing, or receiving for sale, ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets, or specimens without first procuring the license provided for by this chapter."

"2253. The application for a license to carry on such business shall be made to the State Mineralogist . . ."

"2267. Every licensee under this chapter shall file monthly with the State Mineralogist a report of all purchases made under this chapter. The reports shall be made upon forms prescribed by the State Mineralogist and shall contain the information required by this chapter."

Two kinds of ore-buyers' licenses are issued by the Division of Mines: (1) *Limited,* limiting the buyers to $1,000 in purchases for the calendar year; (2) *Unlimited,* carrying no limit on purchases.

Licenses are issued by a calendar-year basis, nearly all of them being issued in January. To mid-July 1951, a total of 83 ore buyers' licenses was issued, of which 39 were unlimited and 44 limited.

MINERAL STATISTICS

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

"2207. The owner, lessor, lessee, agent, manager, or other person in charge of any mine of whatever kind or character within the State shall forward to the State Mineralogist, upon his request, at his office, not later than the thirty-first day of March in each year, upon forms which will be furnished, a report showing the character of the mine, the method of working the mine and the general condition thereof, and the total mineral production for the preceding calendar year. Any such person who fails to comply with the provisions of this section is guilty of a misdemeanor.

Such reports shall be confidential. Other records are public records unless excepted by statute. Statistical bulletins based on these reports and published under the provisions of Section 2205 of this code shall be compiled to show, for the State as a whole and separately for each county, the total of each mineral produced therein, provided that, in order not to disclose the production of any operator, no production figure shall be published which represents the production of less than three operators; and when such production figure for any county would conflict with such provision it may be combined with such production figures for one or more other counties. Such bulletins shall be published annually by June 30th or as soon thereafter as practical."

In order that the figures on mineral statistics will reach the public as soon as possible, they are published in *Mineral Information Service* as soon as they become available. The final summary of all mineral production figures for California for the year 1949, however, appears in the April 1951 issue of *California Journal of Mines and Geology* (volume 47, number 2. These figures are accompanied by a summary of the mineral resources of each of the counties of California, together with a directory of producers, list of the publications of the Division of Mines, and the annual report of the State Mineralogist.

Among producers of minerals, chambers of commerce, and many other agencies, the subject of mineral statistics is an important item. It forms the background of the study of mineral economics. The Division of Mines since 1947 has had a cooperative agreement with the Federal Bureau of Mines to gather and compile mineral statistics in California. Under this agreement the U. S. Bureau sends out all forms to producers asking for information on mineral production, while the Division furnishes names and addresses of new producers. The Division also visits the producers who are delinquent in reporting production and makes an effort to obtain the cooperation of each such producer in complying with the State law in this regard.

The compiled figures, prepared by the Federal Bureau, are sent to the Division as totals by substance and by county; also by substance for each county. Where the county contains fewer than three producers of a mineral substance, figures on that substance are combined with those of other counties to prevent the release of any confidential information.

The cooperative agreement has so far proved to be satisfactory. It avoids duplication of effort between the state Division and the Federal Bureau; it results in securing production figures which are accurate and complete; and it avoids the discrepancies which occurred when the two agencies were collecting production figures independently.

Summary of Mineral Production in California for the Years 1949 and 1950

The value of mineral production in California for 1950 is estimated at $1,040,609,859. This is the third consecutive year that it has exceeded one billion dollars. This figure includes a few final production figures (for gold, silver, copper, lead, zinc, borates, and cement), but the remainder have been estimated, since final figures have not yet been received. In all, the state produces over 60 mineral commodities.

The 1950 estimate indicates about a 3 percent decrease over the 1949 total value, which is largely due to a 7 percent decrease in petroleum production and the fluctuation in crude oil prices.

Cement mills not only maintained their high level of activity in 1950 to meet the demands of the construction industry, but produced the largest annual output on record. A similar high record was made by borates, lead, and liquefied petroleum gases; natural gas and zinc reached an all-time high in value of product. Of the important metals, gold and mercury failed to show an increase.

It is significant that the annual value of minerals produced in California for three consecutive years, 1948, 1949, and 1950, has exceeded one billion dollars. The fluctuation of price and production of mineral fuels so over-shadows all other mineral values, that to show more fairly the mineral situation, the accompanying graph has been prepared to indicate relative values and separate fluctuations of each major mineral group: *mineral fuels, nonmetals,* and *metals.*

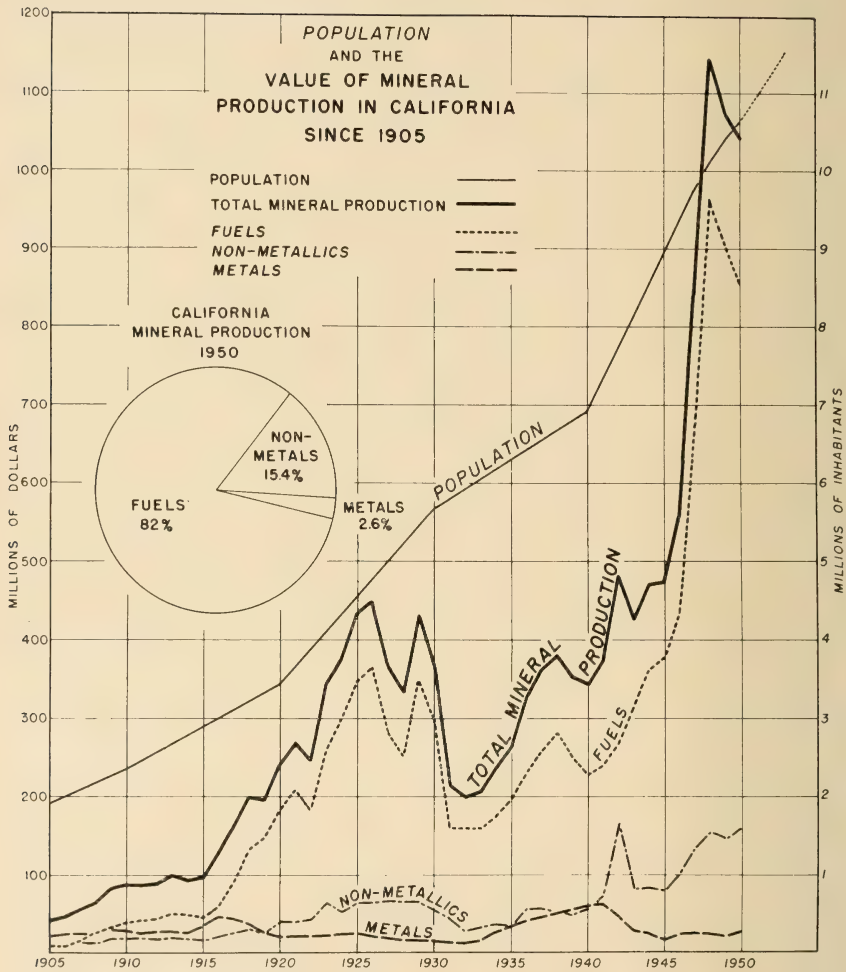

POPULATION
AND THE
VALUE OF MINERAL
PRODUCTION IN CALIFORNIA
SINCE 1905
POPULATION
TOTAL MINERAL PRODUCTION
FUELS
NON-METALLICS
METALS
CALIFORNIA
MINERAL PRODUCTION
1950
NON-
METALS
15.4%
FUELS
82%
METALS
2.6%
POPULATION
TOTAL MINERAL PRODUCTION
FUELS
NON-METALLICS
METALS
MILLIONS OF DOLLARS
MILLIONS OF INHABITANTS
1200
1100
1000
900
800
700
600
500
400
300
200
100
11
10
9
8
7
6
5
4
3
2
1
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950

FIGURE 1

Summary of Mineral Production in California for the Years 1949 and 1950

Mineral commodity	Recorded 1949 production		Estimated 1950 production	
	Value	Quantity	Value	Quantity
Gold	$14,603,085	417,231 fine oz.	*$14,424,130	*412,118 fine oz.
Silver	709,451	783,880 fine oz.	*970,139	*1,071,917 fine oz.
Copper	255,706	1,298,000 lbs.	*268,736	*1,292,000 lbs.
Lead	3,260,488	20,636,000 lbs.	*4,274,370	*31,662,000 lbs.
Zinc	1,787,832	14,418,000 lbs.	*2,144,484	*15,102,000 lbs.
Other metals, including chromite, iron ore, manganese ore, mercury, platinum, tungsten, molybdenum concentrate, titanium concentrate	4,414,155		5,120,000	
Petroleum	752,220,000	332,839,000 bbls.	699,210,000	308,022,000 bbls.
Natural gas	65,825,000	539,550,000 M cu. ft.	67,835,000	556,026,000 M cu. ft.
Natural gas gasoline	65,827,000	862,143,000 gals.	65,780,000	856,632,000 gals.
Liquefied petroleum gases	19,080,000	275,318,000 gals.	20,091,000	286,702,000 gals.
Cement	57,464,213	23,201,982 bbls.	*62,902,000	*26,705,000 bbls.
Miscellaneous stone, including granite, limestone, diatomite, sand and gravel, and crushed stone	42,792,972		43,500,000	
Other industrial nonmetallic minerals, including clay, gypsum, lime, pumice, sulfur, talc, pyrite, etc.	19,417,205		19,200,000	
Borates	11,511,893	467,592 tons	*15,890,000	*647,735 tons
Other salines, including salt, soda ash, salt cake, bromine, calcium chloride, potash, iodine, and magnesium salts	15,247,000		19,000,000	
Total value	$1,074,416,000		$1,040,609,859	

* Final figures for 1950.

SURVEY OF MINING ACTIVITIES

Public Resources Code:

"2208. The State Mineralogist or a qualified assistant may at any time enter or examine any and all mines, quarries, wells, mills, reduction works, refining works, and other mineral properties or working plants in this State in order to gather data to comply with the provisions of this chapter."

Surveys of mining activities in individual counties have been carried on for many years by the Division of Mines and published as summary reports on the mines and mineral resources of each county. The newer reports give a tabulated list of all the mines with data on type of deposits, ownership, and references to published reports, and they are accompanied by maps showing the location of the properties. In addition, a general description of the geology of the county is included.

Reports on the mines and mineral resources of Inyo, Madera, and Yolo Counties were published during the 1950-51 fiscal year in the *California Journal of Mines and Geology.* In addition, reports on Contra Costa, Fresno, Glenn, and Yuba Counties were completed and submitted for publication. Surveys of Los Angeles, Merced, and San Bernardino Counties were under way, and work is expected to start in Amador, Del Norte, and Monterey Counties during the 1951-52 fiscal year.

A continuous survey of mining activities and mineral development is necessary to provide information for the public and to coordinate the diverse activities of the Division of Mines with the changing mineral and other industrial conditions in California. The results of a rapid survey of current activities in the mineral industry by counties were published in the April 1951 issue of the *California Journal of Mines and Geology* together with the 1949-50 annual report of the State Mineralogist. A similar type of survey, but on a commodity basis, was commenced in the 1950-51 fiscal year. This survey will be completed in late 1951. The accelerated national defense program initiated in mid-1950 emphasized the need for this survey, and the preliminary results have proved significant in emphasizing California's part in the emergency.

SURVEY OF MINERAL UTILIZATION

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

Fullest development and exploitation of California's mineral wealth will be realized only when an intimate knowledge of mineral utilization has been gained. The problem of mineral utilization includes marketing and specifications, and ranges in complexity from the simple disposal of gold at an established price to the United States Government, through the marketing of base metals to a relatively few smelters, to the involved and often complicated problem of marketing the nonmetallic minerals. The potential market for California's mineral wealth has grown in proportion to the accelerated industrial development of the state.

In order to develop an understanding of this potential market, the mineral needs and specifications of an expanding industry, both in California and in other states, must first be ascertained; and then this knowledge must be made available to the active and potentially productive suppliers of mineral raw materials. The Division of Mines has attacked the mineral utilization problem in several ways.

A preliminary market survey has been inaugurated by means of a questionnaire to determine the mineral consumption in California's industry. During the latter part of the 1950-51 fiscal year these questionnaires were circulated in the Los Angeles area in cooperation with the Los Angeles Chamber of Commerce. Other chambers of commerce and trade groups are likewise cooperating, and by late 1951 such questionnaires will have been sent to industrial firms throughout the state. Such basic information gained from the survey will form the background for understanding how additional utilization of minerals may be developed. This in time will be made available to California mineral producers.

Cooperation of industry has resulted in publication by the Division of Mines of pertinent information on the mineral needs and problems of certain industries. During the 1950-51 fiscal year the following articles were contributed by the industries and published by the Division of Mines: *Mineral Needs and Problems of the Bituminous Base Roofing Industry, Northern California as a Market for Chemicals*, and *Limestone in the California Beet Sugar Industry*. Also submitted for publication was an article entitled *Mineral Needs and Problems of the Lead-Acid Storage Battery Industry in California.*

Research by staff members of the Division provided the following articles: *Perlite Industry in the Los Angeles Area, Mineral Commodity Conservation in Los Angeles County*, and *Niobium (Columbium) and Tantalum in Modern Industry.* Bulletin 155, *Minerals Useful to California Agriculture* was issued, which shows how the marketing of raw mineral materials in the agricultural industry provides a substantial and significant income to the producer.

A widespread demand for mineral market quotations was met during the 1950-51 fiscal year by incorporating such information as a regular feature in *Mineral Information Service.*

SURVEY OF MINERAL COMMODITIES

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State."

Statewide geologic and economic surveys of individual mineral commodities represent one of the most important activities of the Division of Mines. During the 1950-51 fiscal year, the technical staff completed the preparation of a summary of all the major features of the known mineral commodities of California. As a result, Bulletin 156, *Mineral Commodities of California; Development and Utilization of the State's Mineral Resources,* was published in early 1951. The timely appearance of this summary of California's mineral commodities during a period of national emergency insured its wide distribution. Already it is being extensively used as a basic reference on all mineral raw materials in the state.

Work was continued on the previously initiated detailed mineral commodity surveys of clay, gypsum, kyanite, pumice, perlite, and talc. A study of the fluorite resources of the state was begun and a report on fluorite was published in the October, 1951 issue of the *California Journal of Mines and Geology.*

The clay survey involved geologic mapping of deposits and associated rock formations in the Ione area of Amador County, detailed sampling of clays in this area, and the geology and sampling of clays in the Alberhill area, Riverside County. During the year, compilation of drill-core data obtained in the Buena Vista area of Amador County was completed, and a special report, entitled *Geology and Ceramic Properties of the Clays of the Ione Formation, Buena Vista Area, Amador County, California,* was completed and was being processed for publication at the close of the fiscal year. Information published in this report was utilized during the preparatory stages by clay operators, who have succeeded in locating new commercial clays, in part as a result of that information. The geology and economic study of gypsum throughout the state was completed, and a bulletin on gypsum in California, accompanied by numerous maps, was in the final stage of preparation at the close of the fiscal year. This bulletin will include a summary of California's known gypsum resources and will be of especial value to agriculture in the state.

A study of kyanite deposits near Ogilby, Imperial County, a cooperative project with the Geology Department of the California Institute of Technology, was continued. This will require another year for completion.

Perlite and pumice investigations, including the mapping of deposits of these volcanic materials throughout the state, are nearing completion. At the close of the fiscal year, a bulletin on lightweight aggregate materials, including perlite and pumice, was nearing completion. This bulletin should reach the public during fiscal 1952-53.

Talc investigations throughout the state were nearing completion at the close of the fiscal year with geologic field work practically complete and a large part of a bulletin dealing with statewide talc resources prepared. Emphasis of the most recent talc studies by the Division has been on talcs of steatite grade, which are especially critical.

During the late spring of 1951, the entire technical staff of the Division made a statewide survey of current mining activities and operations according to mineral commodities. This involved a rapid summary field study of actual current mining operations in the more than 60 raw material commodities now being produced in the state.

CONTRIBUTION TO EXPLORATION FOR MINERAL FUELS

Public Resources Code:

"2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

Exploration for petroleum in California continued very actively during fiscal 1950-51 and a number of minor discoveries were made, although none were comparable to those in Cuyama Valley in the two previous years. The petroleum companies expanded their activities to all parts

of the state, including exploration of many areas hitherto believed unfavorable for the occurrence of oil. This broadening of exploratory activities increased the demand for basic geologic information throughout the state. The Division met this demand partly through its Bulletin 118, *Geologic Formations and Economic Development of Oil and Gas Fields of California*, recently reprinted, through the Geologic Map of California, 1938, (now out of print), and through numerous previously published reports. New contributions by the Division include published reports on the geology of eight quadrangles and a special report on the geology of the Bitterwater Creek area in Kern County. A bulletin on the geology of southwestern Santa Barbara County which included geologic information on three major oil fields and a wide area favorable to the occurrence of petroleum had immediate success with the industry and demand for the publication is continuing on a high level. Several reports of interest to the petroleum industry were in press at the close of the fiscal year, and a large number of completed reports are in the Division's files awaiting processing for publication.

A revision of *Economic Map of California No. 2*, scale 1:1,000,000, which shows locations of oil and gas fields and dry holes drilled outside the areas of published oil field maps, was completed, and an accompanying revised list of dry holes, including geologic information, was nearing completion at the close of the fiscal year. This will be ready for the printer early in fiscal 1951-52.

There was little activity on raw materials for mineral fuels during the year, apart from oil and gas. One operation utilizing California coal continued in Amador County, the manufacture of montan wax from lignite of the Ione formation. Peat was mined for agricultural use in several localities in the state. There was no activity in the quarrying of bituminous sand and shale, except that an operation near Casmalia in Santa Barbara County continued to burn petroleum-saturated diatomaceous shale in the manufacture of a material for concrete aggregate.

BASIC GEOLOGIC MAPPING

The surveys of most fundamental value to exploration of mineral resources and of most lasting usefulness are those of geologic mapping, based on accurate topographic quadrangles now available over a large part of the state. Several fine geologic maps have now been published by the Division of Mines and they all have been highly valued by exploration geologists and engineers, agriculturalists, and various agencies.

It is the intention of the Division of Mines to continue this program of mapping. During the fiscal year 1950-51 the Division has published eight such guadrangles with detailed reports accompanying them. As soon as they were released, they were immediately sought by various oil companies; they continue to be in great demand.

Some of the geologic field mapping is done directly by Division of Mines geologists, some by the Federal Geological Survey in cooperation with the Division, and some by professional geologists with various affiliations; the largest contribution has come through the geological departments of the large universities.

The following list shows progress of the basic geologic mapping program to July 1, 1951. The quadrangles listed are 15-minute (scale

1:62,500), unless otherwise indicated. The letter preceding the name of the quadrangle indicates the affiliation of the geologists who are doing the work.

D—Division of Mines
U—University geologist
S—Federal Geological Survey
O—Other professional geologists

The symbol (example, H 15) following the quadrangle name serves as a means of locating it on the index map (fig. 3).

Published, with report:

(U) Antioch (K 16)
(U) Blue Lake (C 15)
(U) Carquinez (J 16)
(O) Gaviota (R 31)
(U) Jamesburg (L 23)
(O) Lompoc (Q 30)
(O) Los Olivos (R 30)
(U) Macdoel, 30-min. (I 1, I 2, J 1, J 2)
(U) Mare Island (I 16)
(U) Mount Vaca (J 15)
(S) Neenach (X 29)
(U) Petaluma (H 16)
(O) Point Arguello (P 30)
(O) Point Conception (Q 31)
(U) Point Reyes (G 16)
(U) Quien Sabe (N 21)
(U) San Benito (N 22)
(U) San Jose (E½)—Mt. Hamilton (W½) (KL 19)
(U) San Juan Bautista (L 21)
(U) Santa Rosa (H 15)
(U) Sonoma (I 15)
(U) Tesla (L 18)
(U) Vacaville (K 15)

Geologic maps published; reports in preparation:

(U) Copperopolis (P 17)
(U) Hollister (M 21)
(O) Lake Elsinore (C′ 34)

Geologic maps and reports in press:

(O) Breckenridge Mt. (X 27)
(S) Cuyama Peak (F′ 37)
(U) Healdsburg (G 14)
(U) Ortigalita Peak (O 21)
(O) Saltdale (A′ 27)
(U) Sebastopol (G 15)

Geologic maps and reports nearly ready for press:

(D) Barstow 30-min. (C′ 29, C′ 30, D 29, D′ 30)
(U) Dardanelles Cone (S 15)
(U) Desert Creek Peak (U 14)
(U) Ferndale (A 6)
(U) Fortuna (B 6)
(S) Gasquet (C 1)
(O) Hines Peak (V 30)
(S) Mother Lode 7½-min. (P 16, Q 17)
(S) Pala pegmatite area 7½-min. (D′ 35, E′ 35, E′ 36)
(D) San Fernando (Y 31)
(S) Santa Catalina Island 7½-min. (X 35, Y 35)
(U) Sonora Pass (T 15)
(U) Wheeler Peak (U 15)

Geologic mapping practically completed; reports in preparation:

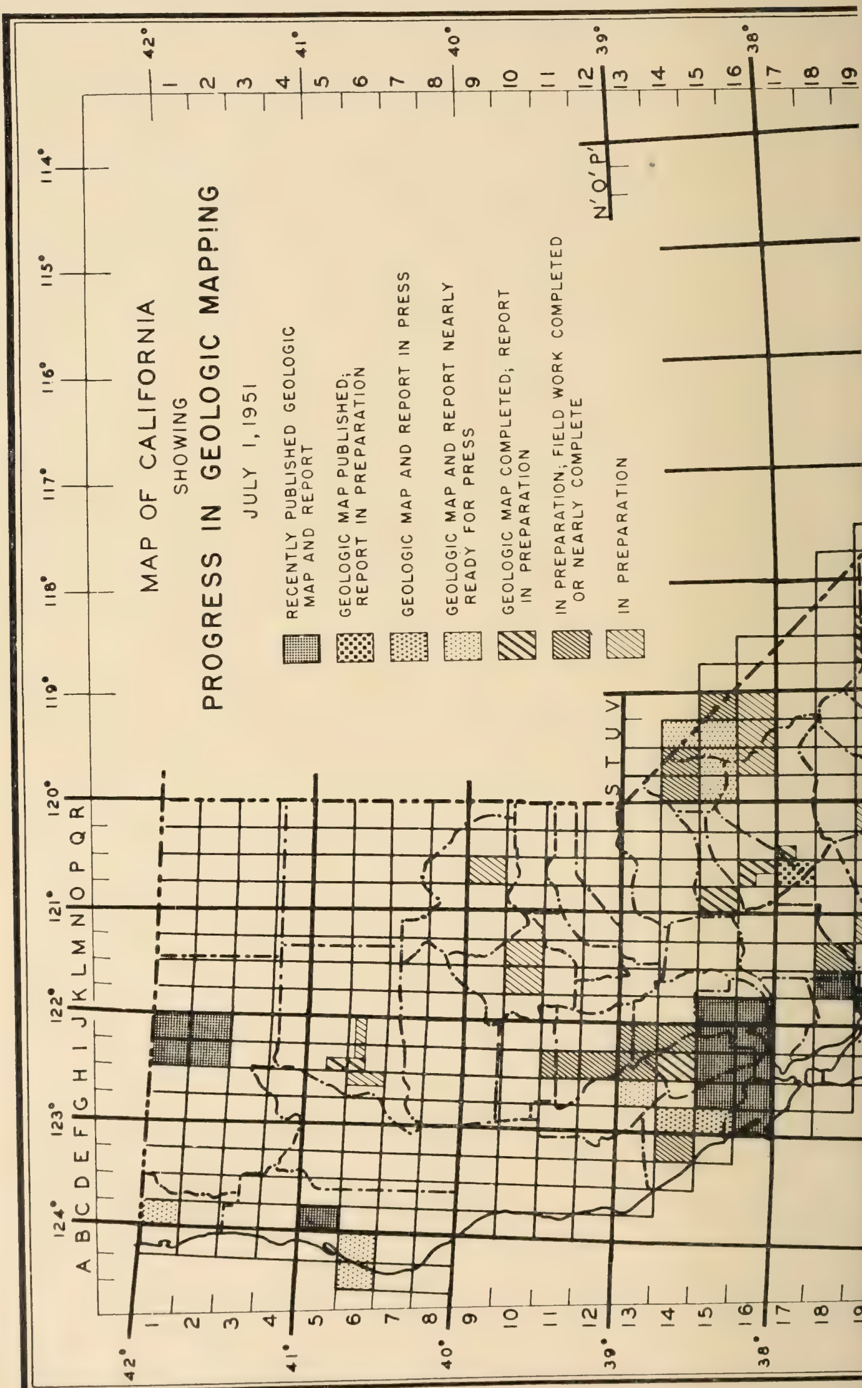
(S) Big Pine (Y 20)
(S) Bishop (Y 19)
(S) Mother Lode (O 15, P 16)
(S) Mt. Goddard (X 20)
(S) Mt. Tom (X 19)
(S) New Almaden (K 20)
(S) New York Butte (A′ 22)
(U) Nipomo (Q 28)
(U) Priest Valley, 30-min. (O 23, O 24, P 23, P 24)
(U) St. Helena (I 14)
(S) Shasta Copper Belt (I 5, 6)
(U) Sutter Creek (O 15)
(S) Ubehebe Peak (B′ 22)

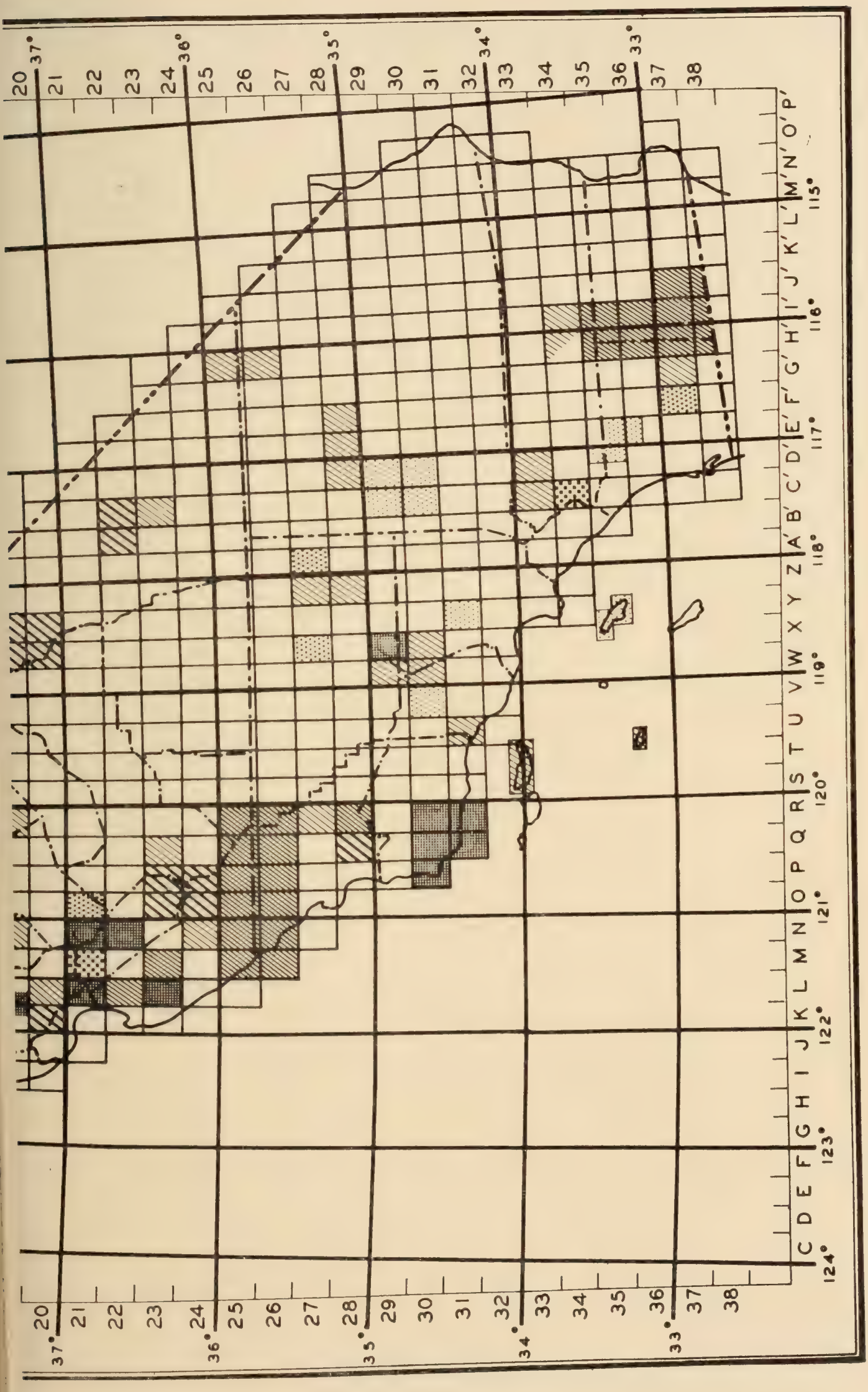
Geologic maps in preparation; field work completed or nearly completed; reports to be written:

(U) Adelaida (O 26)
(U) Bradley (O 25)
(U) Branch Mt. (R 28)
(U) Bryson (N 25)
(U) Capay (J 14)
(U) Cape San Martin (M 25)
(U) Carbona (M 18)
(U) Cholame, 30-min. (Q 25, Q 26, R 25, R 26)
(U) Ebbett Pass (S 14)
(O) Imperial Valley quadrangles
 Agua Dulce (H′ 35)
 Barrel Spring (H′ 36)
 Brawley (J′ 37)
 Carrizo Mt. (H′ 37)
 Coyote Wells (H′ 38)
 Durmid (I′ 35)
 Heber (J′ 38)
 Kane Spring (I′ 36)
 Plaster City (I′ 37)
(U) Lodoga (I 11)
(D) Masonic Mt. (V 15)
(U) Morgan Valley (I 13)
(U) Paso Robles (P 26)
(U) Piedras Blancas (M 26)
(U) Rumsey (J 13)
(U) Salinas (L 22)
(U) San Miguel (P 25)
(U) San Simeon (N 26)
(U) Skaggs (F 14)
(U) Soledad (M 23)
(U) Topaz Lake (T 14)
(U) Wilbur Springs (I 12)

Geologic mapping underway; reports to be prepared:

(U) Alvord Mt. (F′ 28)
(U) Big Bend Mt. (M 10)
(U) Blairsden (P 9)
(U) Cross Mt. (Z 27)
(U) Cuyapaipe (G′ 37)
(S) Darwin (B′ 23)
(U) Indian Gulch (R 19)
(U) Joaquin Rocks (Q 23)
(U) Lane Mt. (E′ 28)
(U) La Panza (R 27)
(D) Matterhorn Peak (U 16)
(U) Mojave (Z 27)
(U) Morgan Hill (L 20)


MAP OF CALIFORNIA
SHOWING
PROGRESS IN GEOLOGIC MAPPING
JULY 1, 1951
RECENTLY PUBLISHED GEOLOGIC MAP AND REPORT
GEOLOGIC MAP PUBLISHED; REPORT IN PREPARATION
GEOLOGIC MAP AND REPORT IN PRESS
GEOLOGIC MAP AND REPORT NEARLY READY FOR PRESS
GEOLOGIC MAP COMPLETED; REPORT IN PREPARATION
IN PREPARATION; FIELD WORK COMPLETED OR NEARLY COMPLETE
IN PREPARATION
A B C D E F G H I J K L M N O P Q R S T U V
N' O' P'
124° 123° 122° 121° 120° 119° 118° 117° 116° 115° 114°
42° 41° 40° 39° 38°
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19


20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
37° 36° 35° 34° 33°
C D E F G H I J K L M N O P Q R S T U V W X Y Z A' B' C' D' E' F' G' H' I' J' K' L' M' N' O' P'
124° 123° 122° 121° 120° 119° 118° 117° 116° 115°

(S) Los Gatos (K 20)
(U) Oroville (L 10)
(U) San Nicolas Island 7½-min. (T 35)
(O) Santa Cruz Island 7½-min. (S 32)
(S) Shasta Copper belt 7½-min. (H 6, I 6, J 6)
(U) Silurian Hills (H′ 26)
(D) Tecopa (H′ 25)

REGIONAL STATE GEOLOGIC MAP

After nearly a decade of careful study and compilation, the *Geologic Map of California,* scale 1:500,000 was printed in colors in six large sheets. It was issued in 1938 and regarded as one of the finest regional state geologic maps in existence. Many areas of the state were left blank for lack of information, however, and many areas were badly in need of revision. Now after 13 years the issue has become exhausted, but the demand for it is greater than ever because the oil companies are exploring over a much broader territory than previously and the nonmetallic industries are just beginning to expand.

The planimetric map base upon which the geologic formations were outlined was issued by the U. S. Geological Survey; but since that time the topography over a large part of the state has been revised and re-mapped. A new base has now been prepared, but it is still in press.

There seems to be no alternative but for the Division of Mines to revise and redraw upon the new base a new state geologic map on the standard regional scale of 1:500,000.

The preliminary work of assembling new data and re-interpreting old data has now begun. It may be advisable to issue this new map in the form of an atlas, capable of being assembled in the form of a large wall map. Hundreds of contributions will be used in its compilation—a task requiring the most careful of coordinated effort. The demand for this map is constant, because it is the most useful of all publications of the Division of Mines.

MINING AND GEOLOGIC GUIDEBOOKS

There is an increasing demand for geologic guidebooks, since Bulletin 141, The Mother Lode Country, was issued. The general public is interested in the study of geology, physiography, and mineralogy, but the ordinary technical reports are too difficult to comprehend without some scientific and engineering background. The *Geologic Guidebook of the San Francisco Bay Counties,* Bulletin 154, and *Evolution of California's Landscape,* Bulletin 158, were still in press at the end of the fiscal year. Another bulletin suited to laymen which the Division of Mines plans to issue, *The Caves of California,* is now being prepared by members of the National Speleological Society.

The Division of Mines published as a supplement to the October 1949 issue of the California Journal of Mines and Geology, *The Elephant As They Saw It,* a collection of contemporary pictures and statements on gold mining in California. This historical record has proved very useful and quite popular, and continues to be in demand. It is intended that other such accounts will be published on the history of early discovery and utilization of minerals and rocks in California. An account of the use of building stone and other raw mineral materials by the early settlers of the state is now in preparation.

The use of minerals by the Indians, before the white man came, is also a subject of interest and concern to many people. From time to time the Division has issued papers on this subject which have proved to be in considerable demand.

The historical background is an approach which draws the interest and leads to a better understanding of why minerals, rocks, landscape, and geologic features in general have controlled the establishment, growth, and expansion of civilization.

MANUSCRIPTS ON FILE FOR PROCESSING

Approximately 50 manuscripts were ready for processing for publication by the Division of Mines at the end of fiscal 1950-51. They were from the following sources: (1) reports by the Division of Mines; (2) contributions from professional geologists and mining engineers; (3) graduate theses and other results of research by members of geological and mining departments of universities. At least half these reports concern basic geology and the occurrence of mineral deposits of areas in various parts of the state. Twelve deal with mineral commodities of particular concern in the national defense program. The others are on various subjects, such as metallurgy, mining, and mineral economics.

In addition to these manuscripts on file in the Division of Mines, there were several other completed reports prepared by the cooperative program with the Federal Geological Survey, which were undergoing editing in Washington, D. C. All of these reports concern detailed geologic mapping of important mining areas in California.

Most of these manuscripts require field checking and many must be amended with chapters on the application to special features of economic concern. They all require careful editing and processing for publication.

CONTINUED GROWTH OF THE LOS ANGELES BRANCH

Several factors have been instrumental in increasing the activities and usefulness of the Los Angeles Branch Office. The mineral utilization survey initiated in this large market area has proved to be a great stimulus to industrial activity and has brought forth a flood of inquiries and demands for more information concerning sources for minerals and markets for them. The national defense program made heavy demands upon the Division's commodity surveys. The public has been particularly anxious to know what federal aid will be available and what legislation has been enacted relative to effecting greater production of strategic minerals. There was a particularly large sale of the Division's publications ($4129.40). Telephone calls (7063) and correspondence (2177) greatly increased.

The field work of the Los Angeles Branch for the most part consisted of the following: (1) county surveys (particularly Inyo, Los Angeles and San Bernardino Counties); (2) commodity surveys (particularly talc and pyrophyllite, but many other commodities—kyanite, andalusite-kyanite-sillimanite, quartz crystals, optical calcite, gem stones, beryl, feldspar, tungsten, molybdenum, gold, silver, lead, and zinc); (3) special studies (Starbright tungsten deposit, Quartz Spring area, perlite processing facilities in the Los Angeles area).

The Los Angeles Branch Office has found it necessary to build up a small but effective local technical library and a significant exhibit of commercial minerals.

Cooperation with other agencies, universities, Federal surveys, and various research workers, as well as the Los Angeles Chamber of Commerce, has been very effective in maintaining the usefulness of the Division and keeping the Division abreast with the work other organizations are doing. There is always close coordination between the Los Angeles Branch Office and the headquarters office in San Francisco. With the much-needed increase in personnel during the 1951-52 year, the Los Angeles Branch Office will be better able to meet the increasing demands upon its services.

REPORT OF THE U. S. GEOLOGICAL SURVEY ON COOPERATIVE PROGRAM FOR FISCAL YEAR 1951

(July 1, 1950-June 30, 1951)

Geologic investigation of the mineralized areas of California by the Mineral Deposits Branch of the U. S. Geological Survey, under its cooperative agreement with the California State Division of Mines, continued at about the same scale during the fiscal year beginning July 1, 1950 as in previous years. Expenditures for the year amounted to about $112,000 as compared with $107,400 spent in the preceding year. Of this total the state provided $50,000 and the U. S. Geological Survey the remaining $62,000. Some of the cooperative funds supported the Federal Survey office in San Francisco, but most were spent in field and laboratory work on six projects: Shasta copper, Mother Lode gold, Bishop tungsten, Cerro Gordo-Ubehebe lead-zinc, Darwin lead-zinc, and California chromite.

In addition to providing $62,000 for the cooperative projects, the Mineral Deposits Branch supported with Federal funds a continuing investigation of quicksilver deposits, costing a little more than $14,000, and put down a diamond-drill hole in the Shasta copper area that cost about $10,000. Geophysical investigations, recommended by the geologists on the Shasta copper project, were begun by the Geophysical Branch of the Federal Survey at its expense, and this activity is continuing into fiscal year 1952.

A major development during the year was the beginning of Defense Minerals Administration work performed under the Defense Production Act of 1950. By this act the U. S. Geological Survey and the U. S. Bureau of Mines were assigned the appraisal of those mining properties for which applications for Government aid for exploration or development were submitted to the Defense Minerals Administration. This appraisal work of the U. S. Geological Survey in California was done partly by geologists on temporary assignment from cooperative projects and partly by added personnel, but entirely at Federal expense through funds provided by Defense Minerals Administration. The Federal Funds provided through the San Francisco U. S. Geological Survey office cover the work of the Defense Minerals Administration in both California and Nevada, and accordingly geologists working out of this office examined many deposits in both states. Because this activity overlapped into Nevada, the exact cost of the California mine examinations cannot be given, but it was about $25,000.

The information obtained from detailed studies of mineral districts under the cooperative program have been of invaluable assistance in this new defense work. It has been utilized in making prompt appraisals, and in some instances led to exploration recommendations that have been followed. A notable example is the New Almaden quicksilver mine, where geologic studies by the Geological Survey in cooperation with the California State Division of Mines pointed to areas in which exploration seemed to be exceptionally promising. Diamond drilling to explore these areas is starting under a defense loan of $150,000. In other instances, the experience the geologist has gained through long-range studies of mineral districts has enabled him to recognize applications for loans that are not sound; as a consequence, public funds and manpower have been saved.

An additional indication that the projects conducted on a cooperative basis during the past six years have been wisely selected comes from private industry. The geologists in the Shasta copper, the Mother Lode, and the Bishop tungsten area have been frequently called upon by mine owners and the personnel of mining companies to discuss the exporation plans that are being devised by the industry.

Shasta Copper. The work of two parties in the Shasta copper area continued without interruption through fiscal year 1951. The party working in the West Shasta area completed the mapping of four 15-minute quadrangles, and all the major mines in the area. Separate detailed reports on the geology and ore controls of the Mammoth and the Shasta King mines were prepared and transmitted to the Mineral Deposits Branch for critical review. The report on the Shasta King mine was submitted to the Division of Mines at the close of the fiscal year for publication. One diamond drill hole was put down with Government funds at the Iron Mountain mine, and a geophysical and geochemical survey was made over the ore bodies of this mine. The geochemical and geophysical work, done primarily to test the applicability of these techniques for exploration in the remainder of the district, was still in progress at the close of the fiscal year. A comprehensive report on the entire area is being prepared.

In the East Shasta area, the work is not as far advanced, and most of the geologists' efforts were spent mapping the geology in detail of an area of 33 square miles. Also a plane-table geologic and topographic map was made of a large area overlying the Bully Hill and Rising Star mines. A report on the geology and ore deposits of the Afterthought mine was transmitted for review near the end of the fiscal year.

Mother Lode Gold. Two geologists, with temporary field assistants, devoted the major part of their time to mapping two 7½-minute quadrangles adjacent to areas previously mapped by the Survey under the cooperative agreement. The mapping of the San Andreas northeast quadrangle was virtually complete at the close of the fiscal year, and the mapping of the San Andreas northwest quadrangle was far enough advanced so that it can be easily completed by the end of the summer field season. Part of the geologists' time was devoted to revision of a report on previous mapping in the San Andreas southeast and Sonora quadrangles and part to mine examinations. One of the major mineral products of this part of the gold belt in the San Andreas northeast quadrangle is limestone, which is quarried for the manufacturing of cement.

An area near the largest cement quarry was mapped in detail by plane-table methods, and a report on the geologic structure of the remaining limestone was prepared. Other limestone lenses of the area, not now being quarried, were outlined in detail on the quadrangle map. Reports on the two quadrangles will be completed in fiscal year 1952.

Bishop Tungsten. The study of the nationally important tungsten area near Bishop continued, although it was interrupted several times when the party chief was temporarily assigned to Defense Minerals Administration activities. Nevertheless, the mapping of the general geology of about 1,000 square miles was completed as planned, and the map compilation and field checking were virtually completed. Geologic sections were prepared and checked by field traverses across the complexly folded and faulted Lower Cambrian rocks on the west flank of the Inyo Mountains. Laboratory study of the ores and associated rocks is under way and probably will be completed in fiscal year 1952. A short report on the Scheelore tungsten mine with detailed maps was completed and placed in open-file at the Division of Mines San Francisco office, where is can be consulted by the public.

Cerro Gordo-Ubehebe Lead-Zinc. Lead-zinc projects have been conducted by two parties working in the adjoining Cerro Gordo (New York Butte) and the Ubehebe Peak 15-minute quadrangles. The work in the Cerro Gordo quadrangle was continued only during the first half of the fiscal year, as personnel assigned to it were occupied with defense assignments during the rest of the year. The geologic map of the quadrangle was virtually completed, and the more detailed maps of areas containing deposits of talc, lead-zinc, and gold were finished. The laboratory study of the fossils, which provide a means of deciphering the complex structure, was completed, and the study of the ore and rock specimens was carried forward. At the end of the year the final report and accompanying maps were partly finished.

The work on the Ubehebe Peak quadrangle consisted of office duties, except for one month spent checking the final quadrangle map and mapping the Lost Burro gold mine. A report on the rocks and structure of the Quartz Spring area, which describes in detail the succession of the Paleozoic rocks, was approved for publication by the Division of Mines. This report provides basic data for reports on the Ubehebe Peak quadrangle and for future work in the surrounding mineralized regions. Other reports dealing with the general geology of the Ubehebe Peak quadrangle and its mineral resources were nearly finished at the end of the fiscal year.

Darwin Lead-Zinc. The Darwin project was begun late in the year. The main objective is a detailed study of the lead-zinc and other mineral deposits within the Darwin quadrangle. Because an experienced geologist to head the project was not immediately available, the studies made during a brief field season consisted of detailed surface and underground mapping of the geology of some of the smaller mines. It is anticipated that the project will be staffed adequately in fiscal year 1952, and then the areal mapping of the quadrangle and the mapping of the major mines will be started.

California Chromite. The preparation of reports on the chromite deposits of California for publication as chapters of Bulletin 134 of the State Division of Mines was continued on a part-time basis. One report

on the deposits of El Dorado County was transmitted to the State Division of Mines for publication, the review of another report on the chromite deposits of the northern Sierra Nevada was nearly completed, and a third on the deposits in the Southern Coast Ranges was transmitted to the San Francisco office of the U. S. Geological Survey for review. A final chapter is scheduled for completion in fiscal year 1952.

San Francisco Office. At the fiscal year's end, the staff of the Survey office in San Francisco, exclusive of Defense Minerals Administration personnel, included two clerk-stenographers, a draftsman, and one scientific aide who worked full time preparing text and illustrations for geologic reports and taking care of correspondence and supplies. During the year 22 reports containing 1,734 pages and 216 illustrations were handled by the office staff. Eleven reports that contain 818 pages and 117 illustrations, chiefly detailed maps, were transmitted to the Division of Mines for publication.

CONCLUSIONS

The policies, functional organization, scope of activities, and procedure of work as outlined in 1947 has resulted in greatly improved service, a wider distribution of published documents, a broader, more authoritative and effective information bureau, and a well-trained professional staff that has produced an unusually large amount of work, as testified by the publications recently issued. Excellent cooperation has been received from universities, Federal and state bureaus, and other scientific organizations, commercial exploration companies, and individuals. The geologic and economic mineral surveys have resulted in new important activities in various industries, which have in turn brought new wealth to the state. Basic information has resulted in building a firmer foundation upon which to construct a greater future mineral industry for California.

The Division of Mines recommends that its program of work be continued, and that its support be made commensurate with the importance of the mineral industry in the state's economy.

THE MINERAL INDUSTRY OF CALIFORNIA—ITS STATUS AND RELATION TO NATIONAL DEFENSE IN 1950-51 *

OUTLINE OF REPORT

* Prepared by the Staff of the Division of Mines, under the direction of L. A. Norman, Jr., Supervising Mining Geologist. A rapid statewide survey of the California mineral industry was made by staff members during the period May-June, 1951. Samuel R. Hoffman has abstracted reports of the survey for presentation herewith. Manuscript submitted for publication September 1951.

Staff contributors: Oliver E. Bowen, Jr., Lewis T. Braun, Charles W. Chesterman, Fenelon F. Davis, George C. Hazenbush, Samuel R. Hoffman, L. A. Norman, Jr., Gordon B. Oakeshott, John C. O'Brien, Salem J. Rice, Richard M. Stewart, Mort D. Turner, William E. VerPlanck, and Lauren A. Wright.

INTRODUCTION

The continued high level of activity of California's mineral industry is demonstrated by the 1950 production, which for the third consecutive year is estimated to have exceeded the one-billion-dollar mark. Much of the total output represents the demands of a post-war industrial growth to meet the requirements of an expanding economy and swelling population. The impetus of the National Mobilization program, however, is reflected in the 1950 output, and also has been responsible for a great surge in activity related to the search for new and the re-examination of known strategic and critical mineral deposits in California. This activity and the pressing demands for other minerals equally important to the program were apparent throughout the state during the rapid survey of the mineral industry conducted by the Division of Mines.

Activity in mineral fuels during 1950 and part of 1951 was marked by a 39 percent increase in exploratory drilling for the first six months of 1951, compared with a similar period for 1950; petroleum production was 11.1 percent higher for the 1951 period than for the same 1950 period. Natural gas output reached an all-time high in value for 1950.

Construction materials contributed heavily to the 1950 activity. Cement production reached an all-time record and was attained by all operating means short of building new plants. New plant facilities and equipment were added by the clay producing and consuming industries. A rapid expansion of uses for diatomite was noted, although about one-half of the annual output of diatomite is consumed as industrial filter material. Limestone as one of the most important basic industrial raw materials was produced and utilized in larger quantities by the cement plants; limestone is also important for glass manufacturing, magnesia production, and sugar refining. Lime derived from limestone ranks high among industry's most versatile chemicals.

Peak production capacity of borax, consumption of gypsum in building materials, accelerated demand for lithium in the national defense

effort, and short supply of salt for an expanding chlorine-caustic industry and for export to Japan were salient events of the saline minerals activities.

Asbestos resources of California are receiving serious attention and widespread activity was noted from Inyo County north to Trinity County. A new discovery of chrysotile asbestos in the Panamint Mountains of Inyo County has evoked great interest. Exploration programs in Nevada and Trinity counties were sponsored by the Federal government. Tremolite-type asbestos was produced from one property in Shasta County in early 1951.

Raw materials to augment sulfuric acid production were in demand and two important elemental sulfur occurrences in Alpine and Inyo counties, as well as lesser known occurrences, were being more fully investigated. The search for pyrite was also expanded.

Tungsten, chromium, manganese, and mercury are important to the defense program. The price of tungsten was stabilized at $63 per unit by the United States Government and has resulted in greatly increased activity in the search for the metal in California, but to date, has not reflected a material production increase. No production of chromite was recorded in 1950, but the Federal government's five-year program for the development of domestic deposits of metallurgical-grade chrome ore has resulted in the reopening of deposits in 1951 in Butte, Del Norte, and Siskiyou Counties. Lack of price stabilization for mercury has presented the principal barrier to more vigorous activity in this old mineral industry of California. Present activity is in districts such as Mayacmas, New Idria, and New Almaden. Manganese mining in California has been stimulated by the sudden increase in price and the lowering of the grade of ore acceptable by the steel industry. One of the larger of the new operations is in the Tracy area.

Zinc, which reached an all-time high in value of output in 1950, is associated with lead-silver and copper-bearing deposits. The Darwin and Tecopa districts of Inyo County were the largest contributors to the output; the newly reopened Afterthought mine at Ingot, Shasta County, was the second largest producer. Lead, as well as zinc, continues in short supply and the California lead-mining activity contributed a 54 percent increase over the previous year. High copper prices, improved metallurgical treatment of complex ores and low-grade ores, and the association of copper with zinc, lead, and tungsten in many California deposits has increased copper production and activity in this state.

The important rare-earth mineral deposits recently discovered in San Bernardino County are being actively explored.

MINERAL FUELS

Coal

Although coal is known to exist in 43 counties of the state, little has been mined since the beginning of the twentieth century. California coal is of either lignite or sub-bituminous rank having correspondingly low thermal values. Because great reserves of oil and natural gas exist in California, the industrial economy of the state has been based on this

supply of plentiful, convenient, and economical fuel. In addition, California coal is not of coking grade so the steel industry of the state has not been able to make use of it.

During the past few years a new industry has developed within the state which has made the United States self-sufficient in a new raw material. This industry is the extraction of montan wax from lignite mined near Ione, California. Montan wax, which was formerly imported from Germany and Czechoslovakia, is similar to carnauba wax and is used in carbon paper, phonograph records, and polishes. Future development of the montan wax industry is closely allied to development of the plastics industry which uses montan wax as an additive and a plasticizer. Other uses of montan wax that have been developed or are under study are as molds for low temperature castings, as an additive in rubber products, for water-proofing heavy-paper concrete forms, and as a plasticizer for resins.

Coke

The production of metallurgical-grade coke in California during 1950 increased 48 percent over that of the previous year to a new high figure of 512,790 net tons. This large increase in production represents the output of 45 new Koppers-Becker slot-type ovens at the Fontana plant of the Kaiser Steel Company. These ovens were added to meet the increased demand for coke when a second blast furnace commenced operation late in 1949. Coking coal used is from out-of-state sources, principally Utah.

Coke produced at the Fontana plant is used as blast-furnace fuel and in the open-hearth production of steel. Important by-products of coking operations include ammonium sulfate for fertilizer, creosote for wood preservative, benzol for insecticide and disinfectant, toluol for T. N. T., phenol for an adhesive in plywood, xylol for use as a paint thinner and a base for synthetic rubber, and other light oil products.

Natural Gas

Even though California is among the large gas-producing states, local supply is insufficient to meet demand, and gas must be imported from other states. At the present time California utility companies are receiving approximately 800 million cubic feet of gas per day from out-of-state sources. This represents nearly half of the state's requirements with the remainder supplied by wells within the state.

California is almost entirely dependent upon natural gas for fuel and heating purposes. Approximately 70 percent of all heated dwelling units in California use gas, and its industrial use is widespread.

Natural Gasoline and Liquefied Petroleum Gas

The light hydrocarbons extracted from natural gas by compression and condensation have become an important factor in the national petroleum economy and presently comprise nearly 10 percent of all liquid petroleum products produced in the United States. Thus, substances that were formerly considered as nuisances and were either dumped or burned have become an industry in themselves, important to our nation in peace and war.

During recent years the production of liquefied petroleum gas has increased about 25 percent each year. High-compression engines, expressly designed for liquefied petroleum gas, are increasing in number and many larger vehicles have converted their engines to use this fuel. Producers of industrial chemicals also consume large quantities of light hydrocarbons. In April 1951 the production of liquefied petroleum gas from California, Oregon, Washington, Arizona, and Nevada together reached 660,000 barrels while that of natural gasoline was 1,511,000 barrels.

Less than half of the light hydrocarbons currently available are liquefied owing to the lack of storage facilities. Proper utilization of our resources of light hydrocarbons can increase the life of our petroleum reserves by 50 percent.

Peat

Peat produced in California is extensively used by florists, nurserymen, and home gardeners as a soil conditioner. Peat does not contain any important amounts of plant food, but it improves the physical structure of the soil and promotes plant development. Peat is not generally used in commercial agriculture, but a market for it is developing among the citrus growers of southern California.

Peat humus, a black soil high in organic matter, is mined at several localities in the state, the most important being Bethyl Island in the Sacramento-San Joaquin River delta and Huntington Beach in Orange County. Vast areas in the Sacramento-San Joaquin River deltas are underlain by sedge and tule peat, a fibrous material composed of stems and stalks of aquatic plants. A submerged area known as Frank's Tract is estimated to contain 25 million cubic yards of tule peat. Peat moss, a highly fibrous and absorbent material formed from aquatic mosses, is mined from a bog in Jess Valley near Likely in Modoc County.

Petroleum

Petroleum production and exploratory drilling in California reached new heights during the first six months of 1951 as a result of increased military demands, a brighter price outlook for low-gravity crude oil, and generally increased industrial activity. During this period 174,346,000 barrels of oil were produced in California; an increase of 11.1 percent over a similar period in 1950. Exploratory drilling was up 39 percent with 280 tests compared to 201 during the first six months of 1950.

Cuyama Valley Area

Since the discovery of the Russell Ranch field in 1948 the Cuyama Valley has been continuously in the news with new fields, new producing sands, and ever-increasing production. In June, 1951, the Cuyama Valley was the fourth-ranking producing area in the state, surpassed only by Wilmington, Coalinga and Huntington Beach. To transport the vast amount of oil coming from Cuyama Valley, the Richfield Oil Corporation recently completed a 125 mile long, 14 inch pipeline from Wheeler Ridge pump station to its refinery at Watson, near Long Beach. This new pipeline, which cost $7,000,000, has a daily capacity of 75,000 barrels.

Russell Ranch Field. The Russell Ranch field is almost completely developed, and in February 1951, 142 wells in this field produced a daily

average of 20,462 barrels of oil. Approximately 25 percent of these wells produce from the Colgrove zone and 75 percent from the higher Dibblee zone. To insure efficient recovery a gas-injection program has been initiated in this field.

South Cuyama Field. Because the South Cuyama field is still in the process of development, the outline of the field has not yet been delimited. The field has recently been extended to the northeast into Sec. 30, T. 10 N., R. 26 W. and the prospects for farther northward extension seem good. In April 1951, a new productive fault block was found at the southern end of the field. The discovery of a new productive sand in November, 1950 was perhaps the most significent development at South Cuyama since its discovery. This sand, named the ''Hibberd Sand'', is below the Dibblee zone, and is correlative with the Colgrove sand in the Russell Ranch field. It has been estimated that this sand will yield oil in approximately 25 percent of the present field area. In February 1951, 184 wells in the South Cuyama field produced a daily average of 34,878 barrels of oil.

Northern Cuyama Valley. During 1950 three small pools were discovered at the northern end of Cuyama Valley. These were the Superior pool of the Morales Canyon field, the Clayton pool of the Morales Canyon field and the Taylor Canyon field. These new fields are much smaller and less important than the previous discoveries and have such complicated geology that step-out failures have been common. In February 1951, a total of 19 wells produced a daily average of 1703 barrels of oil from all three pools.

New Discoveries. During the month of April 1951, two exploratory wells in Cuyama Valley began production in new areas. These wells were Seaboard-Richfield ''Kirschenmann'' 78-22 in Sec. 22, T. 10 N., R. 26 W., and R. B. Watkins' ''Luce'' 1 in Sec. 14, T. 11 N., R. 28 W.

The ''Kirschenmann'' well, which is approximately 3½ miles northeast of the South Cuyama field, is significant in that it is the first discovery in the valley that does not lie along the Russell Fault trend. Production comes from a sand stratigraphically above the Dibblee zone, but which is encountered at a greater depth than the Dibblee zone in South Cuyama. This new field is known as Central Cuyama field.

The ''Luce'' well is midway between the Morales Canyon field and the Russell Ranch field and is producing from the Dibblee zone.

Ventura Basin

Several new fields have been discovered in the eastern part of Ventura Basin. These fields were discovered as a result of the wildcatting that followed Humble Oil and Refining Company's Castaic Junction discovery in the Newhall Mountains in January, 1950. The fields discovered since that time in this region include: the Honer Rancho field, discovered by the Texas Company in August 1950; the Newhall Townsite field, discovered by the Talisman Oil Company in March 1951; and the Northwest Newhall-Potrero field, discovered by Southern California Petroleum Company and General Petroleum Company in July 1951.

Northern and Central Coastal Areas

In recent months there has been an upsurge of interest in the petroleum possibilities of the northern and central coastal areas of California. A number of wildcats have been drilled in these areas and additional ones

have been announced. Counties where wildcatters are active include Monterey, San Benito, Santa Cruz, Santa Clara, San Mateo, Marin, Sonoma and Humboldt. An outpost well near the Tomkins Hill gas field in Humboldt County extended the limits of that field, and in Monterey County the Jergins Oil Company recently found a new pool several miles west of San Ardo oil field.

Recent increases in the price of heavy crude has created new interest in the San Ardo oil field, located in the Salinas Valley in Monterey County. This field was discovered by The Texas Company in November 1947, but was shut down in June 1949 because of the low price being paid for low gravity crude. A total of more than 30 new San Ardo well locations were announced in the period May 26-June 9, and it is expected that as many as 50 new wells will be drilled before the end of the year. The immediate cause of this surge of drilling activity is the new $2,000,000 pipeline constructed by the General Petroleum Corporation between the San Ardo field and Estero Bay near San Luis Obispo.

Northern San Joaquin Valley

Elmer C. von Glahn's "Coleman Community" No. 1, 4 miles northeast of Riverdale oil field in Fresno, was discovered last July. It is the first important discovery in Fresno County since 1943.

This discovery has touched off an intensive leasing and wildcatting program in the Northern San Joaquin Valley. Centers of activity are near the von Glahn well; near Kerman, 15 miles west of Fresno; and near Lindsay in Tulare County where the Bureau of Reclamation encountered 3 feet of tight oil sand in a water well being drilled to study water-table conditions.

NONMETALLIC INDUSTRIAL MINERALS

Abrasives

Since the outbreak of war in Korea, production of sand for sand-blasting material in California has almost doubled. This increase was conditioned primarily by a renewal of activity in shipyards along the Pacific coast. Production of garnet has also risen.

Blasting sands are produced by three companies from natural sands bordering Monterey Bay. Current production averages 1600 tons per day.

Andalusite, Kyanite and Sillimanite

California's andalusite and kyanite mines have not been worked in recent years. The andalusite deposits on the west slope of the White Mountains, Mono County, formerly operated by Champion Sillimanite, Inc., have been unworked since 1945. The kyanite deposits near Ogilby, Imperial County, have been inactive since 1946 when its operator, the Vitrefrax Corporation, was dissolved.

The need for domestic sources of strategic grade kyanite for use in the manufacture of refractories, was indicated in the Defense Mineral Administration's release MO-5 which provided for government loans to assist in exploration for strategic minerals. On approved kyanite projects, such loans cover 50 percent of the cost.

Asbestos

Chrysotile asbestos, one of the strategic mineral materials in which the United States is critically deficient, is known to occur in many counties in California. Although asbestos has been produced and sold intermittently in small quantities in California since 1882, no consistent production has been maintained anywhere in the state.

Most asbestos deposits occur in massive serpentine, a type of rock which is widely distributed in the Coast Ranges, Klamath Mountains, and foothills of the Sierra Nevada. However, early in 1951 a chrysotile deposit was discovered in the Panamint Mountains in Inyo County, in the contact metamorphic zone between dolomite and a syenite intrusion. This discovery, along with a second one made recently in the same area, has attracted widespread attention to a new potential commercial source of chrysotile asbestos.

In 1951, U. S. Government exploration contracts were cleared for the Philip Carey Manufacturing Company to core drill a chrysotile deposit near Washington, Nevada County and one in Trinity County.

Numerous deposits of fibrous tremolite, actinolite, and anthophyllite occur in California. These varieties are commercially termed amphibole asbestos. The fibers are harsher, longer, and weaker than those of chrysotile and cannot be spun, but they have a higher resistance to acids than has chrysotile fiber, and are usually used in preference to chrysotile for filtering acid solutions.

The only production of asbestos in California during 1951 was from the Stock mine in Shasta County. Powhattan Mining Company shipped 44 tons of tremolite asbestos from this mine.

Barite

Occurrences of barite are widespread in California, but only two deposits have been recently active, one in Plumas County and the other in Tulare County. Although barite has a wide variety of industrial uses, most of California's production is used as a weighting agent in oil-well drilling mud. The white pigment lithopone, a mixture composed of barium sulfate and zinc sulfide, is manufactured in California using barite mined in Nevada.

Barite is a common gangue mineral in many of the metalliferous veins in the State. It also occurs in considerable quantity in the bastnäsite deposit discovered recently in eastern San Bernardino County.

Beryllium

Although small quantities of beryl, the principal beryllium-bearing mineral, continue to be recovered from pegmatites in California, there is as yet no proved commercial source of the metal in the state. Because of its small domestic output and its numerous uses in the defense production program, beryllium is one of the most critical minerals.

Black Sands

Deposits of black sands in California contain large reserves of heavy minerals. Use of the Humphreys spiral concentrator has led to extensive production of heavy minerals from alluvial deposits in Florida and has

directed attention to potential western production. Lack of an adequate market for several heavy minerals in black sands is retarding the development of these deposits in California.

Calcite (Optical)

Although calcite crystals of optical and sub-optical grade are still used as polarizing elements in various instruments, the demand for this material is much lower than during World War II. In the manufacture of gun sights, formerly the principal war-time application of calcite crystals, artificially grown crystals of various compounds are now employed.

The calcite deposits in northeastern San Diego County, opened during World War II, have been inactive since 1944. These contain the state's most extensive calcite workings. The Elzie Bagley calcite deposit in Mono County has not been worked since 1925.

Carbon Dioxide

Approximately 200 tons of carbon dioxide is produced in California daily. The chief sources of this gas, in order of relative importance, are as follows: 1. Carbon dioxide manufactured by the combustion of either oil or gas. 2. Carbon dioxide occurring in small amounts in the flammable natural gas produced near Santa Maria. 3. Natural carbon dioxide produced in a more or less pure state from wells in Imperial and Mendocino Counties.

Most carbon dioxide is marketed in solid form for use as an industrial refrigerant. Typical applications are for low-temperature testing of aircraft parts, for chilling finished rubber parts so that irregularities can be removed by grinding, for shrink-fitting metal parts, and for refrigerating blood plasma. Lesser amounts of liquid carbon dioxide are used in the soft-drink industry and in fire extinguishers.

Cement

The continuing shortage of portland cement in California has forced operators to increase production by every possible means short of building new plants. Several firms have made large expenditures in raw material exploration programs and in enlargement of quarrying and mining facilities. The present cement shortage probably will not be materially alleviated by out-of-state or foreign imports because of high transportation costs. The most serious shortage is in packaged cement for the retail trade.

The foremost recent development in the field of portland cement is large scale use of pozzolanic additives. Use of pozzolans is threefold: they are satisfactory low-cost partial substitutes for portland cement where high early strength is not required in the concrete; they latently increase the strength and textural quality of concrete over a considerable period of time (as much as two or three years); and, most significantly, they are effective in combining with alkalies present in most types of portland cement, which otherwise might combine with minerals of some kinds of aggregate to form minerals capable of causing failure in structures. Opaline silica is believed to be the active ingredient in all pozzolans. California Portland Cement Company has pioneered in experimentation and use of pozzolanic materials and the U. S. Bureau of Reclamation is the largest consumer.

Clay

Clay and clay products rank sixth in value of yearly output among the mineral commodities of California. Clay and clay products play a vital part as raw material or manufactured products in almost every industry. To keep pace with the demand for these products the ceramic industry has increased production by installing new machinery and additional plant facilities.

Exploration for new deposits is concentrated in the Ione area of Amador County and along the west side of the Santa Ana Mountains in Orange County. Refractory-clay deposits found in Orange County were of sufficient size and quality to warrant production in the summer of 1951. Bentonite discovered four years ago in San Benito County was mined and shipped to Los Angeles and San Francisco markets during 1951.

In November 1950 part of the largest sewer-pipe producing plant in the world was destroyed by fire. Rebuilding of the destroyed section of the Los Nietos plant was begun immediately.

A new method for the mass production of glazed tile resembling hand-decorated tile was developed by the Pacific Tile and Porcelain Company and its plant at Paramount was expanded to manufacture the new tile. Special shapes in building brick are also much in demand.

Diatomite

Production of diatomite (diatomaceous earth) is rapidly increasing in California, with major operators having difficulty in keeping up with demand. California leads the states in production, and the world's largest quarries are at Lompoc in Santa Barbara County. Statistics are concealed as there are only two operators accounting for nearly all current production.

Uses of diatomite have been increasing but the major general uses are in industrial filters, high-temperature insulation, paper manufacture, and paints. Probably over half the diatomite mined is sold for industrial filters used in clarifying and purifying sugar, pharmaceutical chemicals, brewery products, and a large number of industrial fluids. A variety of insulating products is being marketed. In paper-making, diatomite is used to make a smoother sheet, to improve color, to keep down slimes in the paper machines, and to make the paper non-tacky.

Other applications of diatomite include its use as an anti-caking agent in making ammonium nitrate fertilizer, and as a liquid-absorbing agent (''De-Moist'' is a product made from diatomite and calcium chloride). An intermittent operation near Crows Landing, in Stanislaus County on the west side of San Joaquin Valley, has produced Bobanite, a diatomite sweeping compound. The Airox Company, near Casmalia in Santa Barbara County, is burning petroleum-saturated diatomite for concrete aggregate.

Apart from the small operations near Casmalia and Crows Landing mentioned, two major companies are operating three large diatomite deposits. Johns-Manville Products Corporation is mining and processing diatomite on the north side of the Santa Ynez Mountains at Lompoc, Santa Barbara County, and Dicalite Division of Great Lakes Carbon Corporation is mining diatomite on the north side of the Palos Verdes Hills at Walteria in Los Angeles County and in the Santa Ynez foothills about 4 miles east of the Johns-Manville quarries.

Feldspar

In recent years all but a small part of the feldspar consumed in California has been obtained from out-of-state sources; principally from a deposit near Kingman, Arizona. California's most productive deposit, a pegmatite dike near Campo, San Diego County, was last actively mined in 1942. In 1950, the mill at Campo was used to crush and grind a small tonnage of dump material from the feldspar deposit. Crushed dump material is marketed for use as poultry grit and roofing granules.

The White Butte (Beck) deposit, about 20 miles southeast of Atolia, continued to yield annually several hundred tons of ceramic grade feldspar. The deposit is owned and operated by Gladding McBean and Company which consumes the entire output.

In recent years a highly altered feldspar has been mined from one or two dikes about 3 miles northwest of Bigpine, Inyo County. Most of this material has been obtained from quarries operated by Huntley Industrial Minerals, Inc. Smaller amounts were mined in a nearby quarry operated by Stuart Bedell and J. W. Newman. The feldspar is ground and is used principally as a filler.

Fluorspar

Fluorspar is used principally as a flux in the open-hearth process of steel manufacture. Large quantities of exceptionally pure fluorspar are consumed in the manufacture of hydrofluoric acid. Although demand for fluorspar is large, production in California is small and intermittent. Deposits have been reported in several counties, but no output was recorded in 1950.

Gem Stones

Several gem mines in California were intermittently worked during 1950 and 1951. Pegmatites in the Peninsular Ranges of southern California yielded kunzite, tourmaline, beryl, topaz and quartz. Nephrite jade and chrysoprase were mined from deposits near Porterville in Tulare County. Jadeite was quarried from a newly discovered deposit near Covelo, Mendocino County. The combined recorded output of these operations was considerably smaller, however, than the unrecorded volume of semi-precious gem material gathered by collectors at undeveloped deposits. Moreover, high-grading activities at numerous mines, both active and inactive, probably yielded several times the recorded output.

Of the southern California pegmatites, those in the Pala district attracted the most attention, but gem material was also removed from pegmatites in the Rincon, Mesa Grande, and Ramona districts, all in San Diego County. Production of gem stones in 1950 is estimated at $50,000.

Several hundred pounds of gem quality spodumene were produced from the San Pedro mine, Pala district. Several unusually large kunzite (pink spodumene) crystals were recovered in this operation, which continued from November 1949 to October 1950. The Rose Quartz mine, Mesa Grande district, was reopened early in 1951 and a small quantity of rose quartz was removed, but the operation was intended to develop massive quartz as an industrial material.

The opening of the Porterville nephrite deposit in 1949 marked the first mining of jade in California. The nephrite occurred in a lens, about

10 feet long, 8 feet in maximum width, and extending about 5 feet beneath the surface. By late in 1950 this lens had been removed.

Limestone and Dolomite

Limestone and the many lime products derived from it are basic materials upon which a great many industries important to national defense depend. Lime ranks high among industry's most versatile chemicals and it is fortunate that neither the United States nor California is in short supply. There is, however, a shortage in California of proved reserves of limestone and dolomite that will meet the rigid chemical and sometimes physical requirements of such industries as glass making, magnesia manufacturing, and sugar refining. Much work remains to be done by private or government agencies if large reserves of rock of high purity are to be proved.

Either lime or limestone is necessary in steel and most nonferrous smelting processes, as well as in numerous chemical industries not so obviously related to national defense or any war effort. Manufacture of portland cement and certain other vital construction materials would be impossible without lime or limestone. Calcined dolomite has become the basic ingredient upon which the entire multi-million dollar California magnesia chemical-magnesia refractory business depends. Manufacture of magnesia by interaction of brines with lime has ceased and calcined dolomite is now used exclusively.

Harms Brothers Construction Company acquired the holdings of the former Chubbuck Lime Company, reopened the quarries and kiln at Chubbuck, San Bernardino County, and is planning to open extensive virgin deposits at Cadiz, San Bernardino County. Harms' present production of industrial lime will probably be expanded to include products of other sorts.

Increased demand for granules for built-up roofs has created a very competitive market which several new operators have entered, and to which more established operators are turning their attention. Most of the activity is in white limestone and dolomite, but there is an increasing demand for colored granules, particularly green.

Several current California producers of limestone for sugar refining have been trying to locate suitable deposits as far afield as the McCloud limestone on the Pit river, Shasta County. Several new operators have entered the sugar-rock business. Demand for agricultural limestone, sugar rock, etc., in Oregon has led to new interest in the Kennett (?) limestone at Gazelle, Siskiyou County.

The only new use of lime in California that might contribute materially to limestone consumption is the use of hydrated lime in stabilization of road-base materials. Lime acts as a mild cement and as a clay flocculator in base materials having a substantial clay increment. Portland cement is sometimes used for the same purpose, but is more expensive. Most of the lime used so far has been low-cost, off-color material, obtained from Diamond Springs Lime Company by the State Division of Highways. Use of lime for this purpose will depend on the availability of low-cost limes.

Magnesite and Magnesium Compounds

Nearly all the magnesium compounds produced in California are prepared from sea water or salt works bittern. Only a small tonnage of magnesite was produced in California in 1950. Magnesia refractories are in great demand, and California producers are shipping their products as far east as Utah. The demand for magnesium oxychloride cement, used largely for flooring, has been stimulated by the defense effort.

The Westvaco Chemical Division, Food Machinery and Chemical Corporation's magnesia production is centered in the Newark plant, where magnesia of refractory and other grades is produced from salt works bittern. Magnesium chloride, most of which is used for oxychloride cement, is produced from salt works bittern at Chula Vista. Additional quantities of bittern are used as weed killers and soil sterilizers.

The Kaiser Aluminum and Chemical Corporation produces magnesia from sea water at a plant at Moss Landing. This plant, built in 1942 to supply magnesia for the carbothermic process magnesium plant at Permanente, has been producing refractories since the end of World War II. By changes in technique and procedure, the capacity has been greatly increased. The calcined dolomite, with which the sea water is reacted, is produced at Natividad, and is brought to Moss Landing in trucks. At present some of the magnesium hydroxide produced is shipped without treatment to chemical plants for use as a base material.

A substantial portion of the periclase produced at the Moss Landing plant is consumed in an adjoining refractory brick plant. Using mixtures of periclase and chromite, which are obtained from the Philippine Islands, a wide variety of chrome-magnesia brick is produced.

Merck and Company in February 1951 announced the purchase of the Marine Magnesium Products Corporation, whose plant is at South San Francisco. No immediate changes are planned in the operation. At this plant, the first in the United States to recover magnesia from sea water, specialty magnesias of pharmaceutical grade are prepared.

Mica

Schists rich in sericite or muscovite continue to yield the only commercial mica mined in California. To date the state has had no recorded output of muscovite mica suitable for use as electrical insulator material, the principal strategic application.

The chief sources of the schistose rock in the state near Ogilby, Imperial County, have continued active in recent years. Muscovite schist is ground and bagged at the deposit and is marketed principally as a dusting material for roofing surfaces.

The only other continuing mica operation in California is close to the Huntley pyrophyllite quarry on the west face of the White Mountains, Mono County. This deposit, composed of sericite schist, is operated by Huntley Industrial Minerals, Inc. The material is ground and bagged at Laws and is sold chiefly for use as an ingredient in joint filler used in drywall construction.

Nitrogen Compounds

The General Petroleum Corporation at the Torrance refinery is producing ammonium sulfate for use as a commercial fertilizer. A nitro-

genous by-product gas from the cracking operations is bubbled through refinery sludge, which is waste sulfuric acid. Ammonium sulfate is recovered from the resulting solution by evaporation. The capacity is 11 tons of ammonium sulfate per day.

Pebbles

Rounded pebbles, classified commercially as grinding pebbles, but marketed in California for use with silica sand in layered water filters, are produced from beach deposits near Carlsbad, San Diego County. During 1950 and 1951 the Crystal Silica Company continued to be the only producer of such pebbles in the state.

Perlite, Pumice and Pumicite

The need for lightweight aggregate materials in California has greatly increased. Rising costs of lumber, steel, and other building materials have placed pumice and perlite, which is essentially a synthetic pumice, in a favorable position among other construction materials. Certain pumicites are used as ingredients in pozzuolanic cements. Appreciable quantities are also marketed as abrasive materials in cleansers; recently, pumicite mined in Madera County near Friant was incorporated in a special paper toweling used to clean automobile winshields and other glass objects.

Deposits of expansible-grade perlite have been discovered near Cordelia in Solano County and new perlite processing plants are operating in San Jose, Sacramento, and Fresno. Increased production of perlite is due to several new uses in addition to expanded demand for building materials. Large amounts of perlite are used in the oil industry for oil-well cementing, oil-well acidizing, and in oil-well slurry. Perlite is used in the construction of temperature and shock-resistant structures, such as bombproof shelters. Some perlite also is required as loose-fill insulation for rocket and airplane firewalls, liquid oxygen, and packaging delicate instruments.

Phosphates

The Westvaco Chemical Division, Food Machinery and Chemical Corporation, has put into operation a plant to produce sodium phosphate. The plant is at Newark, adjacent to the magnesia plant. The principal raw materials consumed in the phosphate plant are elemental phosphorous produced in the Company's plant at Pocatello, Idaho, and soda ash obtained from both the West End Chemical Company and the American Potash and Chemical Corporation plants at Searles Lake. Most of the sodium phosphate produced at Newark is used in the manufacture of detergents.

Pyrites

For many years California has been one of the four principal pyrite-producing states. The Mountain Copper Company, Ltd. mined a massive pyrite body in 1950 at its Richmond mine in Shasta County. The chief use of pyrites is in the manufacture of sulfuric acid, which is used in oil refining, the chemical industries, and manufacture of fertilizer. Some gold, silver, and copper is recovered by leaching the cinder residue.

Quartz Crystal

In the defense production program of 1951, as during World War II, quartz crystals, suitable for use in the production of radio oscillator plates, continued to be in critical demand. As in the past, virtually all of this material consumed domestically was being imported, principally from Brazil. The critical need for quartz crystal (piezoelectric) was emphasized by order MO-5 of the Defense Minerals Administration which listed it as one of the minerals eligible for exploration loans. On approved quartz-crystal projects the federal Government agreed to loan 90 percent of the cost.

In the period from the end of World War II to mid-1951, there was no recorded output of quartz crystal (piezoelectric) in California. The Green Mountain and Rough Diamond mines in the placer gravels at Chili Gulch; Calaveras County have been California's principal source of quartz crystal in the past.

Because of newly developed techniques, quartz oscillator plates are now cut much thinner than during World War II, and are metal-plated. More oscillator plates can thus be cut from individual crystals.

Salines

Boron Minerals

The production of boron minerals by United States producers, all of whom are in California, is at peak capacity. The Pacific Coast Borax Company, whose mines are at Boron, Kern County, continues to be the principal producer; the remainder is produced by plants treating the brines of Owens Lake and Searles Lake.

Demand has forced the price of technical borax to $57.25 per ton at the works.

The use of boron material as an agricultural mineral and as an economic poison has rapidly increased, and these uses now consume a significant part of the total production. Boron is one of the micronutrient elements of soils of which plants require a very small but definite amount. Larger quantities, however, are toxic. Although a minute quantity of boron promotes the growth of plants, a large quantity is a potent weed killer that is non-poisonous to animals.

The Pacific Coast Borax Company at Boron is completing the new, centrally located Jenifer shaft. The boric acid plant, built during World War II and idle since the end of the war, is again in operation.

Bromine

Bromine is in great demand, and both California plants are in operation. Most of the bromine produced in California is used in making ethylene dibromide. Much of this is used for antiknock gasoline, but a substantial quantity is used as a soil fumigant. Increasing quantities of bromine are being substituted for chlorine in water purification. It is claimed that bromine-treated water lacks the taste characteristic of chlorinated water.

The principal bromine product of the Westvaco Chemical Division, Plant Food and Machinery Corporation is ethylene dibromide. At present the American Potash and Chemical Corporation is producing elemental bromine only, and the manufacture of alkali bromides has been suspended because of the demand for elemental bromine.

Calcium Chloride

Production of calcium chloride in California is being continued in two operations at Bristol Lake, San Bernardino County. A calcium chloride-sodium chloride brine, collected in ditches dug in the bottoms of old salt pits or in ditches cut through the salt to the underlying clay, is concentrated by solar evaporation to the point where salt precipitates. The calcium chloride liquor is either sold as such, or made into flake calcium chloride.

In addition to miscellaneous uses such as for road treatment, dust prevention, and weed killers, the calcium chloride from Bristol Lake is used by a San Diego firm for the treatment of seaweed in the manufacture of agar agar. Portland cement manufacturers are also consumers.

The receivership of the Desert Salt and Chemical Company (Desert Properties Co.) was dissolved in June 1950, and the property was sold to the National Chloride Company. There have been no changes in the operation.

Gypsum

The California market for gypsum is currently absorbing all the gypsum products, both calcined and uncalcined, that the producers can offer. Since the outbreak of war in Korea, plaster manufacturers have been hampered by a shortage of the paper used for board products. They feel that in case of a national emergency, lack of paper might hinder a further increase in the production of these materials. Under a war economy, it is expected that there will be no great change in the total demand for plaster products, although there will be a change in the type of products in greatest demand.

In agriculture the indications are that in the winter of 1950-1951 more gypsum was used than ever before, exceeding the previous maximum of 490,267 tons applied to California farms in 1947. Most of this, as in the past, was gypsite produced in the San Joaquin Valley. The use of gypsum by dissolving it in irrigation water is increasing.

Sales of anhydrite remain minor compared with gypsum. So far as is now known, anhydrite and gypsum are interchangeable for agricultural use. One large California portland cement manufacturer is using a substantial quantity of anhydrite as a retarder. Patent on a process to make portland cement and sulfuric acid from anhydrite was recently granted.

Iodine

The entire United States' production of iodine is registered by two companies in the Los Angeles area that treat oil field waste water. At present the California companies are supplying essentially the entire United States' demand, and exports are in excess of imports. Both companies are producing at or close to maximum capacity.

The Great Western Division, Dow Chemical Company, continues to produce crude iodine by the blowing-out process. The Deepwater Chemical Company, which uses the silver process, has greatly enlarged its capacity by minor changes in the flow sheet and has completely revised the method of recovering potassium iodide from the ferrous iodide solution. This company ranks among the largest producers of refined potassium iodide, the most important iodine material in use.

Lithium

Since the end of World War II, lithium and its compounds have been the subject of intensive research. The consumption of lithium for newly developed uses is approaching the record amounts used for military purposes during World War II. Today the use of lithium in ceramics as a flux, and in glass, glazes, and enamels is expanding. Lithium stearate soaps, greases, and waxes have valuable properties that are under investigation. Lithium-magnesium alloys are being studied. In organic synthesis, lithium is playing an increasingly important role. Lithium fluoride is used as a flux in the welding of aluminum. Lithium is being studied for use in dehumidifiers, absorbents, dry cells, and for many other purposes. An essential ingredient of the proposed hydrogen bomb is lithium.

In California the Trona operation of the American Potash and Chemical Corporation continues to be the only producer of lithium compounds. Production averages 150 tons a month of a crude lithium concentrate that is produced as a by-product in the recovery of borates and potassium and sodium salts. With a Li_2O content of 21 percent, the lithium concentrate is the highest grade crude lithium material on the market. The demand for it is great, and the company is continually working toward increasing the already high efficiency of the lithium recovery section of the plant.

Potassium Compounds

Although the European producers of potash are again in operation, the American producers are operating at full scale. In California the American Potash and Chemical Corporation, which treats the brine of Searles Lake, is the principal producer of potassium compounds. Products are potassium chloride of agricultural and chemical grade, and potassium sulfate of agricultural grade. In California, potassium sulfate is widely used for agricultural purposes, and comparatively little potassium chloride is consumed. The Trona operation supplies most of the potassium sulfate used in California as well as a substantial portion of the requirements of the Hawaiian Islands.

A second producer of potassium compounds in California is A. M. Blumer of San Francisco. For many years his organization has been distributing potash-bearing agricultural lime. This material is portland cement flue dust, and at present most of it is obtained from the Cottrell precipitators at the Davenport plant of the Santa Cruz Portland Cement Company. The material, which is notably caustic, is largely lime in the form of calcium carbonate and calcium oxide. It contains variable amounts of potassium sulfate up to as much as 15 per cent equivalent K_2O. No attempt is made to sort the material or to control the potash content.

Salt

The expansion of the Pacific Coast chlorine-caustic industry, coupled with the development of a substantial Japanese market for California salt, has stimulated the California salt industry. In general, operations supplying salt for the chemical industry have been greatly expanded.

The Leslie Salt Company has formed a subsidiary, the Leslie Terminal Company, to operate the dock and ship-loading facilities at the

port of Redwood City. The first ship was loaded late in March 1951, but the installation had not been entirely completed in midsummer. At present salt is brought by rail from the washing plants at Newark and Alvarado and stacked near the dock. Evaporating ponds, crystallizing ponds, and a washing plant are under construction near the terminal, but salt is not expected to be harvested from the new ponds for several seasons. Maximum use is made of belt conveyors and remote-controlled equipment. Liberty ships and slightly larger ships are regularly loaded with salt for Japanese and coastwise delivery. The maximum rate of loading is 700 tons per hour.

The Metropolitan Water District of Southern California has concluded experiments conducted at Dale Lake pending action on an application to lease approximately 1840 acres of salt-bearing land. It was determined that by solar evaporation of the brine, with which the crystal body is saturated, salt suitable for water softening can be obtained. At present, the Water District obtains salt from the Bristol Lake operation of the California Salt Company.

Sodium Carbonate

Of the six natural sodium carbonate plants in the United States that are in operating condition, five are in California and treat the brines of Searles Lake and Owens Lake. Normally the production of natural soda fluctuates between 3 and 5 percent of the total supply; the industry is dominated by large ammonia-soda plants in the east that manufacture soda from salt. Except under unusual conditions, natural soda from California is sold only on the west coast where it competes with manufactured eastern soda. Although the natural soda, particularly that from Searles Lake, is of excellent quality, producers have not entirely overcome the prejudice against it resulting from the inferior product made in the early days of the industry.

Sodium carbonate is one of the basic heavy chemicals, and consumption is a reliable index of industrial activity. Existing plant capacity exceeds the normal demand, but the war-stimulated demand is large and unpredictable. During and following World War II, both the natural and ammonia-soda plants were expanded.

In the summer of 1950 the industry was just beginning to recover from the post-war slump when the outbreak of the Korean war enormously stimulated the demand for soda ash. At the same time the closing of the eastern plants by strikes caused an acute shortage that resulted in the curtailment of operations by the consuming industries. Production by the California plants nearly doubled, and natural soda was shipped to the east. Since the resumption of full production in October this critical situation has eased greatly, but the demand for soda remains high. It is expected that soda will not be plentiful during the present international crisis. None of the California plants have announced plans for expansion.

Sodium Sulfate

Sodium sulfate, like sodium carbonate, is an important heavy chemical, most of the supply of which is synthetic. Ninety percent of the United States production is used by the paper industry. Prior to World War II, the United States' supply came largely from Germany. When that source was cut off, a number of natural deposits were developed. Now that the

capacity of synthetic salt cake plants in the United States has been increased, the prospect for increased production of natural sodium sulfate is less favorable.

In California the American Potash and Chemical Corporation at Trona recovers sodium sulfate by treating by-product sodium salts obtained from from the main evaporators. For the past two winters additional sodium sulfate has been obtained directly from the upper structure brine by spraying it during cold weather. The mirabilite that forms is scraped up, trucked to Trona, and added at the appropriate place in the soda products plant. The spraying season lasts for a few weeks only.

Sand and Gravel

Most sand and gravel is used in concrete, which is a vital construction and paving material. Large quantities are consumed as road metal and railroad ballast, both necessary to the maintenance of the nation's transportation system. Smaller but important amounts of glass sand, moulding sand, and other special sands are used by industry. Production of sand and gravel in California is nearly twice as great as in any other state.

The greater part of the sand and gravel produced in California comes from long established and steadily worked quarries in all parts of the state. They range in size from one-man operations to plants with a capacity of 1000 tons an hour. Two counties, Alameda and Los Angeles, are the sources of 43 percent of the sand and gravel in California.

In addition to sand and gravel production to fill regular building needs there are pits in all parts of the state that produce or have produced large quantities of aggregates during the construction of a single large structure such as a dam, bridge, or canal. Enormous amounts of sand and gravel were required to build the Friant-Kern canal, the Delta-Mendota canal, and the Tracy pumping plant. A number of dams were under construction in 1951, including Folsom dam, Isabella dam, and Pine Flat dam. Although flood-control structures augment the normal demand in the construction industry they do not deplete reserves required for local use.

Slate

Slate production in California is small but important to the construction industry of the state. A large proportion of the asphalt-base roofing manufactured in the state contains slate granules as a surfacing material. Slate flour is used as a filler in road-asphalt surface mixtures. There is, in addition, a significant amount of slate flagstone produced for use in walks and steps. All slate used in California for roofing slate, blackboards, and electrical slate is quarried in the eastern United States, largely because of established marketing practices.

In California in 1950 there were five producers of slate, three more than in 1949. The largest and steadiest production has been from a mine at Chili Bar, El Dorado County.

Stone

The construction industry is heavily dependent upon crushed stone as a basic ingredient of structural concrete, and the transportation industry requires stone aggregate for paving, road metal, and railroad

ballast. In addition, crushed limestone is used in large amounts in the steel, agricultural, and sugar industries. Dimension stone is quarried for use as ornamental and structural stone.

About half of the stone crushed in California is derived from cobbles removed from sand and gravel at aggregate-screening plants. It is either sold separately or mixed with sand and gravel to give a desired size range. Other types of rock used extensively as sources of crushed stone are sandstone, granite, basalt, and limestone.

Because two-thirds of the California crushed stone is used for aggregate in construction, the principal sources of supply are near Los Angeles and San Francisco.

In addition to the major uses for crushed stone there are many small but important ways in which special types of rock are utilized, such as in the ceramic and chemical industries. A recently developed use for a mica rock from the Owens Valley region has led to the marketing of this material. The mica rock is finely ground and used as a paint extender and as a rubber filler for battery boxes.

Strontium Minerals

None of the celestite and strontianite deposits in California has been worked since the close of World War II. The present price offered for crude celestite, $20 a ton, f.o.b. cars, California, 90 percent grade, is far below the $30 to $35 a ton reached in 1942 and 1943.

Sulfur

The shortage of sulfur that developed in the latter part of 1950 has resulted in a new interest in California's known elemental sulfur deposits, the principal ones being located in the Last Chance Range, Inyo County and near Markleeville, Alpine County. Native sulfur has also been noted in 7 other counties. During 1950, California produced agricultural sulfur only in a relatively small amount from deposits in Inyo and Lake Counties.

Sulfur is consumed by all types of industry and enters into many types of products. Much of the sulfur is converted to secondary products, most important of which is sulfuric acid. About 68 percent of the national consumption of sulfur in 1950 was by the fertilizer, chemicals and miscellaneous, and petroleum industries.

Sulfuric Acid

The outbreak of the Korean war and the subsequent national defense mobilization has emphasized the role of sulfuric acid as the "workhorse" of industry. The acid has more varied uses and is consumed in larger quantities than any other industrial chemical.

California's output of sulfuric acid was necessarily increased in mid-1950 to meet the great demand of the petroleum industry for manufacturing aviation gasoline and other petroleum products. Production by mid-1951 was considerably higher than the previous year.

Sulfur and sulfur-rich materials from within and without the state provide raw materials for sulfuric acid manufacture. Pyrite mined in Shasta County and hydrogen sulfide gas from a metal refinery at Selby and several petroleum refineries in the state are important sources of such raw materials.

In August 1951, a new sulfuric acid plant that cost one- to one-and-one-half million dollars was placed in operation at Vernon by Stauffer Chemical Company, augmenting the production facilities of several plants located in the Los Angeles and San Francisco Bay areas.

Talc and Pyrophyllite

The talc deposits in California are largely confined to three areas which have been designated as the Inyo Range, southern Death Valley-Kingston Range, and Silver Lake talc provinces. Pyrophyllite occurs under geological conditions quite dissimilar from talc although these minerals are employed in many similar uses. In 1950 an all-time high of more than 100,000 tons of talc and pyrophyllite was produced in California.

More than half of California's talc output is consumed by the ceramic industry. Much of the talc mined in the Death Valley and Silver Lake areas is marketed as an ingredient of wall tile. Most of the remainder of the talc produced in eastern California is consumed by the paint, rubber, and textile industries. Smaller amounts are used in insecticide carriers, in cosmetics, and for various minor industrial applications. Most of the talc and soapstone from the Sierran foothill belt is used as a filler in the manufacturing of roofing and as an insecticide carrier. Nearly all the pyrophyllite mined in California has been marketed as insecticide diluent.

In mid-1950, the defense mobilization program placed greatly increased demands on the nation's resources of the high-purity talc known as "steatite" used in the manufacture of high-frequency electrical insulators. Steatite deposits in California supplied all but a small part of the domestic requirements during World War II. Since then deposits of comparable purity in Montana have been developed and are currently producing more steatite than the California sources. Hindrances to the production of steatite in California were the expense and time required to develop new reserves in the long-established operations, and the haulage distances to the less extensively worked deposits. Another difficulty confronting steatite producers is how to distinguish steatite from non-steatite talc in the field. This difficulty has hampered some mine operators and has complicated the estimation of steatite reserves.

METALS

Antimony

Small, scattered deposits of antimony occur in several localities in California. Urgent demand and high prices have stimulated interest in the deposits, particularly those in Kern, San Bernardino, Inyo, and San Benito Counties. During 1951 the Cordero Mining Company continued development work at the Quien Sabe antimony mine in the Stayton district, San Benito County.

Antimony has a variety of uses in both metallic and non-metallic products. The greatest use for the metal is as an alloying element in lead. Antimony is also used in the manufacture of frits, ceramic enamels, paints, lacquers, plastics, glass, pottery, flameproofed textiles, and ammunition primers.

Chromite

Chromite is a strategic mineral commodity because it is an essential constituent in the manufacture of stainless steel as well as other steel alloys, and because the entire U. S. production of chromite has always fallen far short of supplying the domestic requirements, even under the high prices and lowered grade requirements of wartime. California chromite production, three-quarters of which was mined during World Wars I and II, has a significant contribution in times of national emergency.

Early in 1951, the Defense Minerals Administration announced a 5 year program for development of domestic deposits of metallurgical-grade chrome ore. A stockpile depot, established at Grants Pass, Oregon, has stimulated interest in chromite mining in California. Several mines in Del Norte, Siskiyou, and Butte Counties produced small amounts of chrome ore during 1951.

Copper

Copper has been a strategic metal of short supply and increasingly great demand in the United States in 1950 and 1951. Except for a brief slump in the market in mid-1949, copper demand has been well in excess of domestic production and this trend is expected to continue for some time. Increased use of copper and brass in the building industry, government stockpiling, and military needs is chiefly responsible for the present high demand. Military requirements are estimated to reach 45-80 percent of the total available supply. To increase copper supplies the excise tax of 2 cents per pound for all imported copper, which was in effect from July 1, 1950, to April 1, 1951, has been suspended until February 1953, or the end of the national emergency.

Principal markets for copper and brass, besides military production, are the automotive, building, and electrical appliance fields, all extremely active in 1950. Production of copper tubing for plumbing reached an all-time peak in 1950. Its unprecedented demand was created by the boom in building activity and its ever-widening use in hot and cold water lines, vent, waste, and soil lines, radiant and other heating uses, and in gas services. In the first half of 1951, California continued to build at twice the national building rate, although a sharp decline from the 1950 peak was evident. In addition to the decreased demand for copper for building uses in 1951, a decline in sales of radios and home appliances as well as automobiles points to lowering copper requirements in these industries. However, increased demand for copper for military uses has more than made up for the lower copper requirements of these peacetime industries. Increasing demand for copper alloys for electric power equipment—motors, generators, and switchboards—followed the general expansion of heavy industries for emergency production in the first half of 1951.

Several factors have stimulated recent copper mining in the state. All indications are that the present high prices will continue for some time. Improved metallurgical techniques have made it profitable to mill complex ores and low-grade ores that were formerly not economical. The recognition of zinc as an important metal of high value has made profitable the mining of many zinc-copper orebodies not previously mined

because the value of copper alone would not return a profit. The abundance of dissolved copper in mine waters has enabled several mines to produce precipitation copper to help pay rehabilitation expenses or to augment regular production. These factors have contributed to the recent reopening of several of the state's old mines that had been closed under former economic and metallurgical conditions.

Recent activity in copper mining in California has been primarily directed toward reopening old mines rather than development of new deposits. Only one entirely new deposit was active in 1951. This is the Donner Mine, near Milton, Calaveras County, which was discovered in October 1950.

Ferro-Alloys

Ferro-alloys are used principally in the production of iron and steel as deoxidizing agents or to give the steel certain desired physical properties. Ferrosilicon is the only ferro-alloy currently being produced commercially in California. Ferrosilicon is used in the production of metallic magnesium and will be greatly in demand for the newly reopened magnesium plant at Manteca which uses the Pidgeon ferrosilicon process.

Gold

The California gold production in 1950 dropped 1 percent from that of 1949. This followed the diminishing trend started in 1948. High mining costs, lack of experienced miners and increasing difficulty of getting supplies and equipment are all factors in this downward trend. The principal hindrance is the fixed price for gold ($35.00 per fine ounce).

The total gold production in California is estimated at 412,118 ounces, about 60 percent of which came from placer operations and 40 percent from lode mines. The areas in California which contain the most productive primary gold deposits are the Grass Valley-Nevada City district and the Mother Lode belt, both in the western foothills of the Sierra Nevada. Placer gold has been mined from many localities in the state, chiefly in the northern counties.

Gold is used principally for monetary purposes. Next in importance is its use in the manufacture of jewelry, watches, and gold leaf for decorative purposes. Industrial uses for gold, which stem largely from its resistance to corrosion, have been found in the electrical, dental, and chemical industries.

Iron and Steel

Iron, used principally in the form of steel, is unquestionably the most important metal in United States industry in war as well as peace. Production of iron and steel during 1950 increased markedly to supply expanded military and industrial demands. California provides a minor but growing share of the country's iron; 1950 production of 840,000 tons was 56 percent greater than in 1949, but was only 0.86 percent of the nation's production.

California iron and steel production has been stimulated by general industrial expansion occasioned principally by an unprecedented population increase. Armament program requirements have not yet had a direct effect on California's steel industry except in the aircraft building field, which requires machine tools to shape parts and assemblies.

The relatively slight demand for iron ore to be used as a temperature control in quick-setting concrete has increased slightly as have the requirements for open-hearth-steel furnace charge. Virtually no California iron ore has been used in the last several years for ship ballast, heavy aggregate, heavy media or paint pigment.

In 1951 California iron ore production is expected to advance to nearly a million and a half tons. Steady expansion at the Eagle Mountains mine in San Bernardino County is principally responsible for this increase, aided somewhat by limited shipments to Japan from smaller mines.

Lead

California production of lead, a metal in short supply since the outbreak of war in Korea, increased 54 percent during 1950. This output set a new record for the state and the higher rate of production continues in 1951. Mines in Inyo County have been the principal producers of lead, chiefly due to the operations of the Anaconda Copper Mining Company at the Darwin and Shoshone mines.

About 39 per cent more lead was used by domestic industry during 1950 than in 1949. As in previous years, the use of lead in storage batteries consumed the greatest amount; its use in cable coverings followed. This high consumption trend continues. Established users of lead are requiring more by reason of expansion. In addition, more lead may be substituted, either completely or in part, for such scarce metals as tin, in solders and coatings on steel, aluminum, in collapsible tubes and foils, and zinc, for coating on steel. The domestic supply situation has been further tightened because of the war in Korea by the increase in foreign lead demand. This resulted in less lead from foreign mines pressing for sale in the United States.

Magnesium

Although magnesium is a metal of great potential value, its comparatively high price and incompletely developed technology have discouraged its large-scale industrial use. The most important uses of magnesium depend upon its weight and strength. The greatest quantities are used for airplanes, but minor amounts are used for light-weight tools and machinery. The use of magnesium in photoengraving is growing. A new use of magnesium is the cathodic protection against corrosion of steel pipe lines, tanks, and other structures that are buried or immersed in sea water.

The rising military demand for magnesium caused the federal government to reopen a number of the government-owned plants, which have been held in stand-by condition since the end of World War II. Among them is the plant at Manteca, which produced 24 million pounds of magnesium from 1942 to 1944. This plant, having a capacity of 20 million pounds of magnesium per year, is operated by the Kaiser Magnesium Company using the Pidgeon ferrosilicon process.

Manganese

Manganese, an essential constituent in the manufacture of steel, is one of the commodities for which the United States is almost entirely dependent on foreign sources of supply. Although manganese minerals are wide-

spread in California, most of the deposits are not sufficiently high in grade to compete with rich foreign deposits in times of peace. Thus nearly nine-tenths of the total manganese output of California was produced during World Wars I and II, when prices were higher and grade requirements lower than in peacetime.

Early in 1951 there was an extremely short supply of the higher grades of manganese ore, owing to the stepping up of the national defense program combined with the cessation of virtually all shipments of ore from the U.S.S.R. In February the Defense Minerals Administration placed delivery and use of manganese ore containing over 35% Mn under allocation control. Consequently, the price of foreign ores containing 46-48% Mn rose from 79.8-81.8¢ per unit of contained Mn to as high as $1.22-1.26 per unit, and the steel industry began accepting domestic ores containing as little as 20% Mn. This situation has stimulated interest in manganese mining in California, and several mines are being developed for production.

One of the largest scale developments is in San Joaquin County, where Taylor-Knapp Company, producer of battery-grade manganese, has organized a California division, with headquarters at Tracy. This company is constructing a mill 3 miles south of Tracy to handle ore produced from the Ladd mine. Open-cut operations have been initiated at the mine, with an output of 100 tons of ore per day as an eventual goal.

At Inca, Riverside County, the Blythe Manganese Company has almost completed construction of a 200 ton mill for treating ores which they will mine from the Arlington and Landon claims.

Early in the year the Owl Springs Company opened the Big Reef manganese mine near Ludlow, San Bernardino County, and has shipped ore to the Geneva Steel Company in Utah. Morton Construction Company has developed the Blue Jay and Bonanza mines near Ruth, Trinity County, for operation under a government purchase contract. Near Crescent Mills, Plumas County, the Lakeview mine and the Crescent Heights and Prince Albert claims are being developed for production.

Mercury

Mercury is an essential constituent of industrial control instruments and electrical apparatus. Accelerated industrial and military demands occasioned by the Korean war have placed mercury in short supply in the United States. Soon after the outbreak of hostilities in June 1950 foreign producers initiated a series of sharp price advances which trebled the price of mercury in a period of seven months. Some domestic mercury producers began to rehabilitate their properties cautiously with the expectation that a government price stabilization program would be established. Such a program would justify more extensive capital outlays for reconditioning mines and ore-treatment plants which had shut down earlier in 1950 owing to the low price of mercury prevailing at that time. No price-stabilization program, however, had been established up to September 1951.

California production of mercury dropped during 1950 to its lowest level since 1921. The Mt. Jackson mine in Sonoma County was the only major property in the United States producing mercury continuously through 1950 and 1951. Current activity centers about the long established districts, such as Mayacmas, New Idria, and New Almaden. In-

tensive drilling programs and production of ore from California mines in 1951 indicate that mercury production for this year will exceed that of 1950 by at least 50 per cent.

Molybdenum

Molybdenum, as well as other ferro-alloying metals, was in short supply in the U. S. by the end of 1950. Although the nation's molybdenum reserves are much larger than are its reserves of most other ferro-alloying metals, greatly increased demands were placed by the defense effort on existing production facilities. In anticipation of even greater demands molybdenum producers are taking steps to increase production.

Molybdenum minerals have been found at numerous localities in California. Several deposits have been mined in the past. For the last several years, however, the only molybdenum-producing property in California has been the U. S. Vanadium Company's Pine Creek mine near Bishop in Inyo County. The molybdenum at Pine Creek occurs in molybdenite and powellite. These minerals are associated with scheelite in a tactite ore body. The molybdenum is recovered as a by-product of the tungsten operation.

Platinum

For many years an average annual production of a few hundred ounces of platinum and other metals of the platinum group has been obtained as a by-product of placer gold operations in California. Small quantities of platinum-group metals are also recovered as by-products of refining gold and copper ores.

The strategic importance of platinum-group metals is such that the National Production Authority has prohibited their use in non-essential items, largely jewelry. Platinum-group metals are important catalysts in the production of high octane fuels, nitric acid, and other chemicals. Platinum and palladium are important in electrical apparatus where they are used as contact points in magnetos, spark coils, and spark plugs. Where the specific qualities of platinum or platinum-group metals are indicated, no completely adequate substitutes are available.

Silver

In California, as well as in the rest of the United States, most of the current silver production is obtained from base-metal ores. The Darwin and Tecopa districts of Inyo County are the largest producers in the state. Silver production in 1950 increased 37 percent over 1949.

Silver consumption during 1950 represented a peacetime high, due largely to increased silverware manufacturing. However, there is an increase in the use of silver as a substitute for metals under allocation. During World War II, over 900,000,000 ounces of silver were leased by industry from the Treasury. Over 400,000,000 ounces of this "busbar" silver is still held, principally at the Atomic Energy Commission's Oak Ridge plant.

Titanium

No activity in the mining of titanium ores was carried on in the state during 1950. In past years, titaniferous iron ores have been mined in the western San Gabriel Mountains and ilmenite-magnetite has been obtained from black sands in the San Gabriel Mountains at Redondo

Beach, and at Aptos in Santa Cruz County. The latest activity in the mining of titaniferous sands was in Sand Canyon in the western San Gabriel Mountains where stream sands were being mined to produce a titanium concentrate. Some of the concentrate was sold for the manufacture of titanium pigment and some was used in heavy rollers. This operation at the Live Oak mine in Sand Canyon was inactive during the past year.

Tungsten

The defense production program has greatly stimulated interest in California's tungsten resources. Short supply and increased demand has caused the price of tungsten to more than double since July 1950. The interest shown by the government in increasing domestic production has resulted in the stabilization of the price of tungsten ores at a price of $63 per unit and in a revision of the government purchase program for the national stockpile.

Increases in activity have centered largely about the tungsten-bearing areas that have been the principal past producers. These include the Bishop district on the east side of the Sierra Nevada, the Atolia district in the Mojave desert and the Fresno and Kernville districts on the west side of the Sierra Nevada.

In spite of the greatly increased activities however, no great rise in production had occurred by July 1951. This was largely because most of the work done has been in prospecting, road building and reopening of old workings.

Few significant tungsten discoveries in California have been made in recent years. The only post-World War II tungsten discovery that had reached production by July 1951 was the Starbright mine, about 25 miles northeast of Barstow, San Bernardino County. This mine, discovered in the spring of 1950, is of particular interest because it lies in a district where past tungsten production has been unimportant.

Uranium, Thorium, and the Rare-Earth Elements

Large reserves of rare-earth minerals were discovered recently in California. Near Mountain Pass in San Bernardino County development of a bastnäsite ore body by the Molybdenum Corporation of America is proceeding. Thorium is also present in the rare-earth minerals discovered in this area. Small quantities of minerals containing uranium, thorium, and the rare-earth elements have been reported from other localities in the state.

Uranium and thorium are of prime importance as sources of atomic energy. The pronounced success of the atomic bomb as a military weapon at present overshadows the potential use of atomic energy for peacetime applications. However, the future development of fissionable elements to provide energy for industry will be one of the greatest advances in technology ever achieved. Radioactive elements currently produced in atomic piles have proved invaluable to scientific research. Several of the rare-earth elements are of interest in atomic research owing to their "poisoning effect" (absorbtion of slow neutrons) on the action of nuclear energy piles.

Table 1. California counties in order of total value of recorded mineral production to and including 1949.

County	Year of first recorded output	Rank, value of output in 1949	Value of total output	Value of 1949 output	Principal minerals in order of total value for 1949
Los Angeles	1880	1	$3,976,448,826	$262,694,189	Petroleum, natural gas gasoline, natural gas, miscellaneous stone.
Kern	1880	2	3,033,702,755	251,749,473	Petroleum, natural gas gasoline, natural gas.
Orange	1889	5	1,247,969,005	92,505,148	Petroleum, natural gas gasoline, natural gas.
Fresno	1880	3	1,035,932,604	122,001,066	Petroleum, natural gas, natural gas gasoline.
Ventura	1880	4	809,979,216	97,103,752	Petroleum, natural gas gasoline, natural gas.
San Bernardino	1880	7	594,042,862	39,846,593	Cement, borates, potash, miscellaneous stone.
Santa Barbara	1881	6	519,472,508	52,629,378	Petroleum, diatomite, natural gas gasoline.
Kings	1894	8	361,541,194	28,792,437	Petroleum, natural gas gasoline, natural gas.
Nevada	1880	19	[1]250,650,693	[1]4,033,957	Gold, miscellaneous stone, silver.
Shasta	1880	25	214,242,096	2,127,372	Miscellaneous stone, zinc, pyrite, gold.
Sacramento	1880	9	205,148,650	15,544,122	Natural gas, gold, miscellaneous stone.
Riverside	1891	11	173,608,403	10,015,932	Cement, miscellaneous stone, gypsum.
Santa Clara	1850	10	163,862,295	14,566,606	Cement, miscellaneous stone, raw clay.
Amador	1880	32	155,705,858	904,789	Gold, raw clay, coal.
Calaveras	1880	17	146,424,168	5,047,431	Cement, gold, zinc.
Inyo	1880	15	146,064,432	7,372,421	Lead, zinc, tungsten ore.
Alameda	1890	12	134,938,268	9,696,590	Miscellaneous stone, salt, magnesium compounds.
Yuba	1880	24	118,931,753	2,261,095	Gold, miscellaneous stone, silver.
Santa Cruz	1894	18	112,364,661	4,671,289	Cement, miscellaneous stone.
Solano	1873	13	103,266,932	9,073,140	Natural gas, miscellaneous stone.
Plumas	1880	50	82,682,202	177,036	Miscellaneous stone, barite, gold.
Butte	1880	29	81,682,853	1,415,097	Gold, miscellaneous stone, natural gas.
Contra Costa	1894	30	81,612,511	1,249,973	Miscellaneous stone, natural gas, raw clay.
San Mateo	1895	16	78,006,972	5,267,012	Cement, miscellaneous stone, magnesium compounds.
San Benito	1865	23	69,199,473	2,332,368	Cement, miscellaneous stone, quicksilver.
Placer	1880	42	62,084,478	454,817	Miscellaneous stone, raw clay, gold.
Tuolumne	1880	35	58,601,354	783,822	Miscellaneous stone, lime, gold.
Sierra	1880	40	54,889,204	531,902	Gold, miscellaneous stone, silver.
Siskiyou	1880	33	54,539,733	886,098	Gold, miscellaneous stone, pumice.
San Diego	1880	22	51,453,124	2,427,135	Miscellaneous stone, salt, pyrophyllite.
Trinity	1875	49	49,835,122	267,577	Miscellaneous stone, gold, silver.
El Dorado	1880	28	49,295,376	1,550,024	Miscellaneous stone, lime, gold.
Napa	1862	44	46,192,978	395,251	Miscellaneous stone, pumice.
San Joaquin	1885	21	37,694,913	2,502,537	Miscellaneous stone, natural gas, gold.

Mono	1880	46	34,176,150	338,673	Pumice, pyrophyllite, tungsten ore.
Mariposa	1880	48	32,177,571	325,732	Gold, barite, miscellaneous stone.
Merced	1880	34	32,044,610	834,482	Gold, miscellaneous stone, silver.
Monterey	1889	20	30,962,989	3,906,363	Magnesium compounds, miscellaneous stone.
San Luis Obispo	1876	14	24,861,973	7,751,072	Petroleum, miscellaneous stone, gypsum.
Sonoma	1873	31	24,655,013	1,005,526	Miscellaneous stone, quicksilver, petroleum.
Stanislaus	1880	37	23,583,720	653,482	Gold, miscellaneous stone, natural gas.
Lake	1873	53	21,684,146	78,623	Miscellaneous stone.
Tulare	1880	26	20,146,726	1,738,887	Miscellaneous stone, natural gas, tungsten ore.
Madera	1893	39	17,183,700	599,296	Natural gas, pumice, gold.
Marin	1888	36	16,693,515	741,278	Miscellaneous stone, clay.
Imperial	1907	27	16,480,352	1,692,930	Gypsum, miscellaneous stone, carbon dioxide.
Humboldt	1880	38	14,033,105	636,604	Miscellaneous stone, natural gas, gold.
San Francisco	1894		[3] 8,732,104	[3]	Gold, silver.
Del Norte	1880	52	6,258,754	144,969	Miscellaneous stone, chromite.
Glenn	1893	47	[2] 4,798,805	[2] 336,008	Natural gas, miscellaneous stone.
Yolo	1873	43	4,772,342	443,044	Miscellaneous stone, natural gas.
Colusa	1875	55	4,327,013	38,195	Miscellaneous stone.
Mendocino	1880	41	[3] 3,926,608	[3] 502,027	Miscellaneous stone, carbon dioxide.
Lassen	1880	51	3,045,704	170,580	Miscellaneous stone.
Modoc	1880	54	2,285,794	59,159	Miscellaneous stone, pumice, gold.
Tehama	1880		[2] 1,804,472	[2]	Miscellaneous stone, chromite.
Sutter	1908	45	1,374,536	356,096	Miscellaneous stone, natural gas, raw clay.
Alpine	1880		[1] 370,974	[1]	Tungsten concentrates, miscellaneous stone.
Total recorded value by counties 1850-1949 inclusive			*$14,712,448,149		
1949 total value				$1,074,416,000	

* Less than tabulated total for the whole State (shown on Table 2) because, except for a few quicksilver producing counties, California county records go back no farther than 1880. State-wide production records began with 1848.

[1] Total recorded production through 1946; 1947-1949 output of Alpine County included with Nevada County.

[2] Total recorded production through 1946; 1947-1949 output of Tehama County included with Glenn County.

[3] Total recorded production through 1946; 1947-1949 output of San Francisco County included with Mendocino County.

Table 2. Value of total recorded mineral production in California by substances to and including 1949.

Mineral products in order of total value	Year of first recorded production	Total value to 1949 [f] inclusive	Value of 1949 output [f]	Year of peak value	Year of peak output	Order of principal producing counties in 1949 (value)	Remarks
Petroleum	1865	$9,514,124,026	$752,220,000	1948	1948	Los Angeles, Kern, Fresno, Ventura	California's output is exceeded only by Texas. The total value of California's petroleum output is greater than the total of all other mineral products.
Gold	1848	2,311,516,451	14,603,085	1852	1852	Nevada, Sacramento, Yuba	California led the nation in the output of gold until 1941. In 1949 the state ranked second.
Cement	1891	791,236,670	57,464,213	1948	1948	San Bernardino, Santa Clara, Riverside	State output only surpassed by Pennsylvania.
Natural gas	1888	761,956,314	65,825,000	1949	1948	Los Angeles, Sacramento, Fresno, Solano	Output only exceeded by Texas.
Miscellaneous stone	1893	597,755,736	42,792,972	1948	1948	Los Angeles, Alameda, San Diego, San Bernardino	Leads the nation in output of sand and gravel, and ranks high in stone.
Copper	1882	198,704,694	255,706	1916	1909	Shasta, Inyo, San Bernardino	Shasta led from 1897-1918; Plumas from 1919-1940; and Siskiyou from 1941-1944.
Borates	1864	181,772,810	11,511,893	1947	1947	Kern, San Bernardino, Inyo	Chief source of world's supply.
Brick and hollow tile	1893	175,032,616	d	1923	--------	Los Angeles, Contra Costa, Sacramento	Approximately half the annual value is for fire brick.
Mercury (quicksilver)	1850	148,837,189	357,014	1943	1877	Sonoma, San Benito	Led the nation with approximately 45 percent of output in 1949.
Potash	1914	[h]87,944,792	*	1947	1947	San Bernardino	Second among the states.
Silver	1880	75,753,165	709,451	1921	1921	Inyo, Shasta, Nevada	State's output derived as by-product of other metals.
Soda (soda ash and salt cake)	1894	[g]70,604,697	4,163,714	1948	1948	San Bernardino, Inyo	Leads the nation in output of natural soda and sodium sulfate.
Salt	1887	56,646,632	4,110,271	1949	1949	Alameda, San Diego, San Bernardino.	Ranked sixth among the states in 1949.
Tungsten ore	1905	45,590,369	*	1943	1943	Inyo, San Bernardino, Tulare	Ranked first among the states with approximately 35 percent of nation's output in 1949.
Diatomite	1889	[h]47,598,524	*	1947	1947	Santa Barbara, Los Angeles	California is the chief source for the nation.

Mineral water	1887	[b]40,601,881	[b]	1930	1930	Los Angeles, San Bernardino, Marin	Represents that which is bottled for sale.
Clay (raw)	1887	33,835,038	2,744,069	1948	1948	Kern, Riverside, San Bernardino, Los Angeles	Ranks high among the states.
Lime	1894	32,470,692	2,516,262	1948	1947	Monterey, El Dorado, Tuolumne	Lime was included as limestone 1941-1946.
Granite	1887	29,585,027	[c]	1925		San Diego, San Bernardino, Fresno	Cannot compete with concrete construction.
Lead	1877	28,014,290	3,260,488	1948	1949	Inyo, Shasta, San Bernardino	Darwin district principal producing area.
Limestone	1894	[b]26,075,905	[c]	1946	1946	El Dorado, San Bernardino, Tuolumne	For industrial purposes, and not including that for cement.
Coal	1861	23,453,760	39,000	1880	1880	Amador	Coal from Amador County mined for its wax content.
Zinc	1906	20,832,802	1,787,832	1945	1926	Inyo, Shasta, Calaveras	Output is marginal.
Magnesium compounds	1916	20,432,112	1,770,000	1944	1944	San Mateo, Monterey, Alameda	Second among the states.
Magnesite	1887	[b]19,290,994	*	1917	1917	Santa Clara	Natural mineral is being replaced by magnesia from sea water.
Gypsum	1887	18,839,407	1,852,452	1948	1948	Imperial, Riverside, Kern	Third among the states in 1948.
Pyrite	1898	[b]16,365,248	*	1909	1909	Shasta	Output ranks third among states in 1946.
Talc, soapstone, pyrophyllite	1893	14,287,214	1,434,046	1948	1948	San Bernardino, Inyo, Mono	Second among the states as to value.
Chromite	1869	12,957,841	11,662	1918	1918	Butte	California's output was first among the states in 1945.
Iron	1881	[b]9,728,121	*	1949	1943	Riverside, San Bernardino	With the construction of the Fontana steel plant in 1942 production showed a marked increase.
Silica	1899	[b]9,410,764	*	1946	1946	Quartz-San Bernardino, Kern. Glass sand-Monterey, Riverside	California is an important source for quartz and glass sand.
Iodine	1929	[b]7,851,461	*	1946	1946	Los Angeles	Only production in nation.
Pumice and pumicite	1909	6,614,492	799,602	1948	1948	Inyo, Mono, Madera	Leads the nation in output.
Paving blocks	1887	[b]5,712,288		1912	1912		Has been replaced with smooth paving.
Manganese ore	1887	[b]5,124,616	*	1944	1944	Plumas, San Bernardino	1944 output was only surpassed by Montana and Nevada.
Dolomite	1915	[b]4,971,453	[c]	1946	1945	Monterey, San Benito, Tuolumne	A large percent of the output goes into the reduction of magnesia from sea water.
Sandstone	1887	[b]4,700,255	[c]	1903	1900	Monterey, Napa	Production of dimension stone has decreased in recent years.
Bituminous rock	1887	[b]4,650,320		1888	1910	Santa Cruz, Santa Barbara (in past)	A possible future source of oil.
Bromine	1926	[b]4,567,266	*	1944	1944	San Bernardino, Alameda	The state is an important source.
Bentonite	1899	[b]3,703,611	[a]	1928	1928	San Bernardino, Inyo, San Diego	California is an important source of bentonite.
Barite	1910	[b]3,604,813	*	1945	1945	Mariposa	The state is an important source of barite.
Marble	1887	[b]3,587,755	[c]	1909		San Bernardino, San Luis Obispo	Hard to compete with artificial stones.

Table 2. Value of total recorded mineral production in California by substances to and including 1949—Continued.

Mineral products in order of total value	Year of first recorded production	Total value to 1949 [f] inclusive	Value of 1949 output [f]	Year of peak value	Year of peak output	Order of principal producing counties in 1949 (value)	Remarks
Gems	1900	[h]$2,631,532	[b]	1906		San Diego	Includes optical minerals. Production irregular.
Molybdenum	1916	[h]1,994,483	*	1943	1943	Inyo	Produced as a by-product of tungsten ore.
Calcium chloride	1921	1,958,697	$204,024	1926	1926	San Bernardino	Second among the states.
Carbon dioxide	1894	[h]1,773,564	*	1944	1944	Imperial, Mendocino	State is an important source of natural carbon dioxide.
Lithium compounds	1899	[h]1,470,049	*	1946	1920	San Bernardino	California leads the nation.
Slate	1889	[h]1,420,017	*	1906		El Dorado, Tuolumne	Used chiefly in roofing granules.
Platinum metals	1887	[h]1,194,216	*	1922	1940	Sacramento, Yuba, Merced	Output only exceeded by Alaska.
Feldspar	1910	[h]1,067,285	*	1928	1928	San Bernardino, Madera	Recent output used as filler.
Sillimanite group	1922	[h]969,919		1926	1926	Mono, Imperial (in the past)	Past output was andalusite and dumorterite.
Sulfur	1865	876,778	26,444	1941	1941	Inyo	Production irregular.
Peat	1935	563,801	35,193	1946	1946	Contra Costa, Orange, San Diego	Is sold as a soil conditioner.
Grinding-mill pebbles	1915	[j]358,677	*	1916	1917	San Diego	Output small.
Mineral paint	1890	[h]249,038	[c]	1893	1903	San Bernardino	Output small and irregular.
Antimony	1887	226,936		1916	1916	Inyo, Kern (in past)	Output has been intermittent and of little importance.
Strontium	1916	212,258		1942	1942	Imperial, San Bernardino (in the past)	Second in nation, 1946.
Mica	1902	[j]198,574		1947	1947	Imperial (in past)	Most mica mined in California was sericite variety used as ground mica.
Asbestos	1887	[h]170,292	*	1910	1921	Shasta	Output all of amphibole variety in 1949.
Titanium	1927	[j]165,980	*	1928	1928	Los Angeles	Several deposits of ilmenite are known in the state.
Onyx and travertine	1887	[h]122,219	[c]	1894		Solano, Mono (in past)	Output irregular. Total to 1926.
Shale oil	1922	109,500		1924		Santa Barbara (in the past)	A future source of oil.
Graphite	1901	87,495		1922	1922	Los Angeles (in past)	No output in recent years.
Tin	1891	62,534		1892	1892		Several occurences are known in the state.
Serpentine	1896	[h]47,218	[c]	1946	1946	Santa Clara	Is now being used in fertilizers.
Garnet (abrasive)	1939	[h]24,795	*	1945	1945	Inyo	By-product from tungsten ore tailings.
Calcium silicate	1933	23,854		1938	1938	Kern (in past)	Used in the manufacture of mineral wool.

Cadmium	1917	16,489		1917	1917		Cadmium reported as a by-product from zinc ores.
Fluorspar	1917	8,912		1934	1944		Output has been intermittent.
Perlite	1946	h4,873	*	1946	1946	Inyo, San Bernardino, Napa	First production was included with pumice.
Bismuth	1904	2,400		1904			A bismuth concentrate was made in 1942 but not shipped.
Arsenic	1924	1,356		1924			Production only reported in 1924.
Zircon	1932	1,310		1941		Placer (in past)	Small amounts of zircon sand found in most black sand.
Alum minerals	1938	160		1938		Riverside (in the past)	Occurrences of alum minerals have been noted at several places in state.
Total value for 1949			1,074,416,000				Since 1947 the total value of California mineral output exceeded a billion dollars.
Total recorded value including 1949		15,498,359,323					

* Figures appear only in state total for year because this substance was reported by less than three operators.
a 1947-1949 output included with raw clay.
b Not canvassed by U. S. Bureau of Mines (1947-1949).
c 1947-1949 output included with stone.
d 1947-1948 output included under heavy clay products, not included in 1949 totals.
e 1948 totals included with iron ore.
f 1947-1949 production figures compiled by U. S. Bureau of Mines. Previous statistics by California State Division of Mines.
g Does not include salt cake in 1948-1949.
h Total value up to 1946 inclusive; for 1947-1949, figures appear only in state total for year because this substance was reported by less than three operators or was included with another mineral commodity.
j Total value up to 1948 inclusive.

Zinc

Zinc produced in California has been obtained largely from two sources: mines in the desert regions of eastern California that are also sources of lead and silver, and copper-bearing deposits of the Sierran foothill belt and Shasta County. Zinc output in California for 1950 was 5 percent higher than in 1949. Inyo County produced more than 76 percent of the total amount; the Darwin and Tecopa districts contributed most of the zinc as a by-product of lead-silver ores. The newly reopened Afterthought mine at Ingot, Shasta County, was the second largest producer.

The domestic consumption of zinc during 1950 was the highest in history. The expansion of the galvanizing, die-casting, and alloy industries is increasing the demand for zinc. However, the direct military requirements are less than 15 percent of the zinc being consumed because of the increased use of steel in cartridge cases. This figure is considerably lower than that during World War II. The consumption of zinc by nondefense industries has been limited by the National Production Authority since January 1, 1951. It is expected that consumption of zinc during 1951 will be nearly one million tons, or about 50,000 tons greater than in 1950.

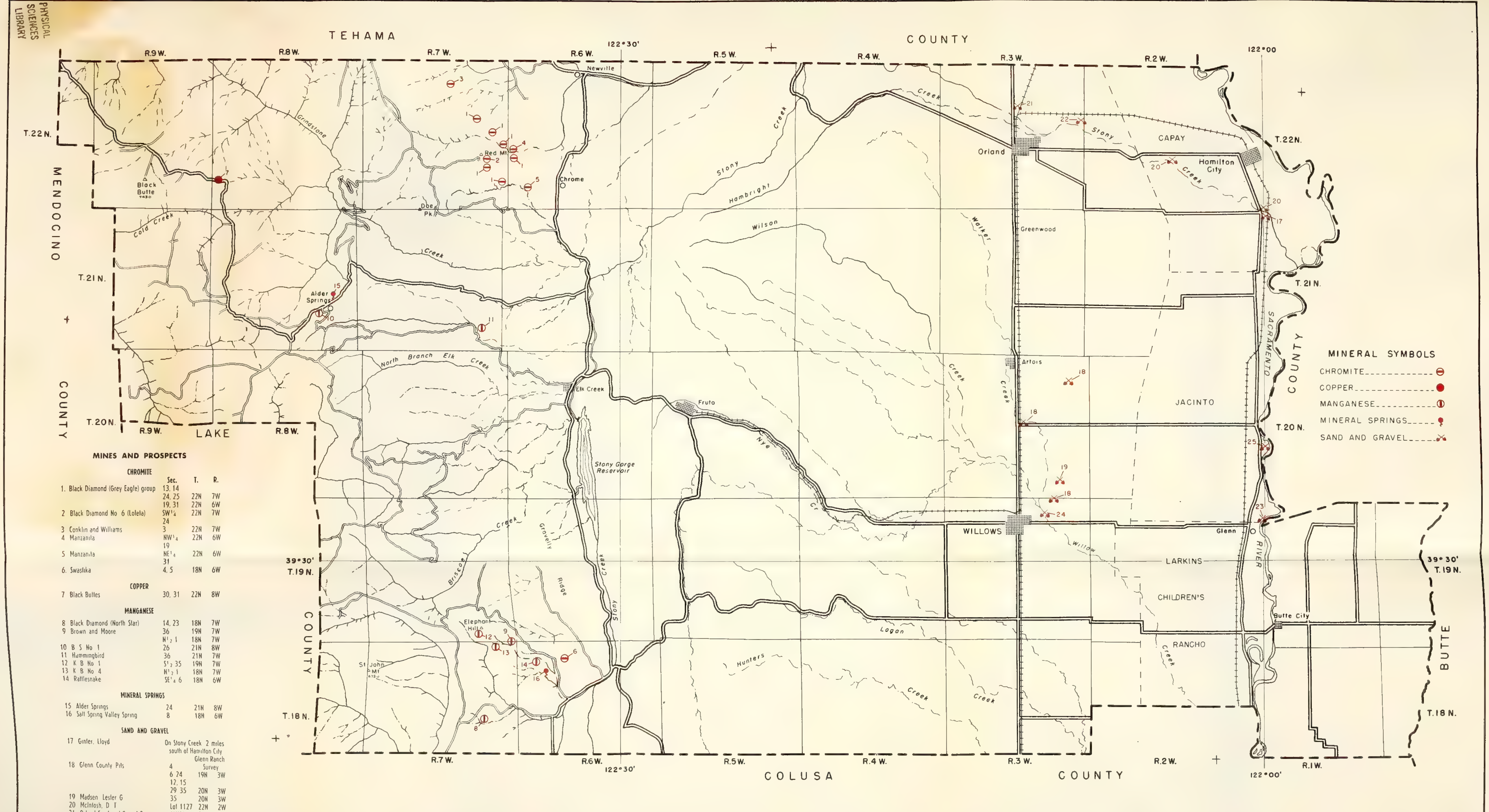
Zirconium

Zirconium is a vital alloying element in steel and nonferrous alloys. It is used in vacuum tubes, ammunition primers, time fuses in bombs, armor-piercing bullets, and in many other essential products for waging war.

Zircon, the mineral from which zirconium metal is extracted, is a common constituent of alluvial deposits of heavy minerals. Black sands in California often contain high percentages of zircon but interest in the recovery of this mineral has lagged owing to the lack of an adequate market in the west.

o

printed in CALIFORNIA STATE PRINTING OFFICE
51511 10-51 2M



MINES AND PROSPECTS

	Sec.	T.	R.
CHROMITE			
1. Black Diamond (Grey Eagle) group	13, 14		
	24, 25	22N	7W
	19, 31	22N	6W
2 Black Diamond No 6 (Loleta)	SW¼ 24	22N	7W
3 Conklin and Williams	3	22N	7W
4 Manzanita	NW¼ 19	22N	6W
5 Manzanita	NE¼ 31	22N	6W
6. Swastika	4, 5	18N	6W
COPPER			
7 Black Buttes	30, 31	22N	8W
MANGANESE			
8 Black Diamond (North Star)	14, 23	18N	7W
9 Brown and Moore	36	19N	7W
	N½ 1	18N	7W
10 B S No 1	26	21N	8W
11 Hummingbird	36	21N	7W
12 K B No 1	S½ 35	19N	7W
13 K B No 4	N½ 1	18N	7W
14 Rattlesnake	SE¼ 6	18N	6W
MINERAL SPRINGS			
15 Alder Springs	24	21N	8W
16 Salt Spring Valley Spring	8	18N	6W
SAND AND GRAVEL			
17 Ginter, Lloyd	On Stony Creek 2 miles south of Hamilton City		
18 Glenn County Pits	4	Glenn Ranch Survey	
	6 24	19N	3W
	12, 15 29 35	20N	3W
19 Madsen Lester G	35	20N	3W
20 McIntosh, D T	Lot 1127	22N	2W
21 Orland Sand and Gravel Co.	NW¼ 15	22N	3W
22 Southern Pacific Railroad Company	13	22N	3W
23 Thuemler, T P	66	19N	2W
24 Thuemler, T. P	W½ SW¼ 2	19N	3W
25. Wruck Brothers and Davis	S½ 42	Jacinto Ranch Survey	

MINES AND PROSPECTS OF GLENN COUNTY, CALIFORNIA

SCALE
1 ½ 0 1 2 3 4 5 MILES

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 48 APRIL 1952 No. 2

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

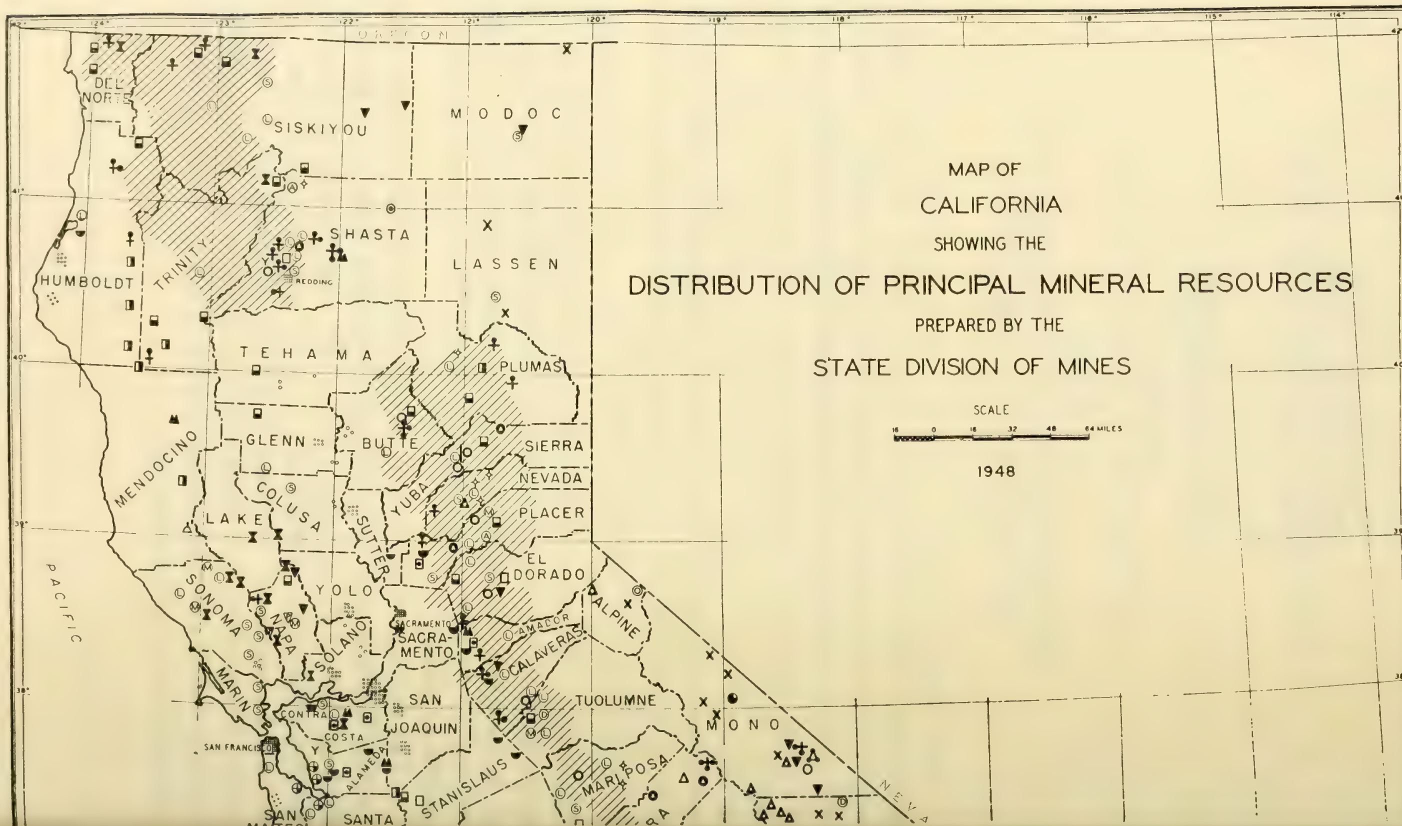
Headquarters
Third Floor, Ferry Building, San Francisco 11

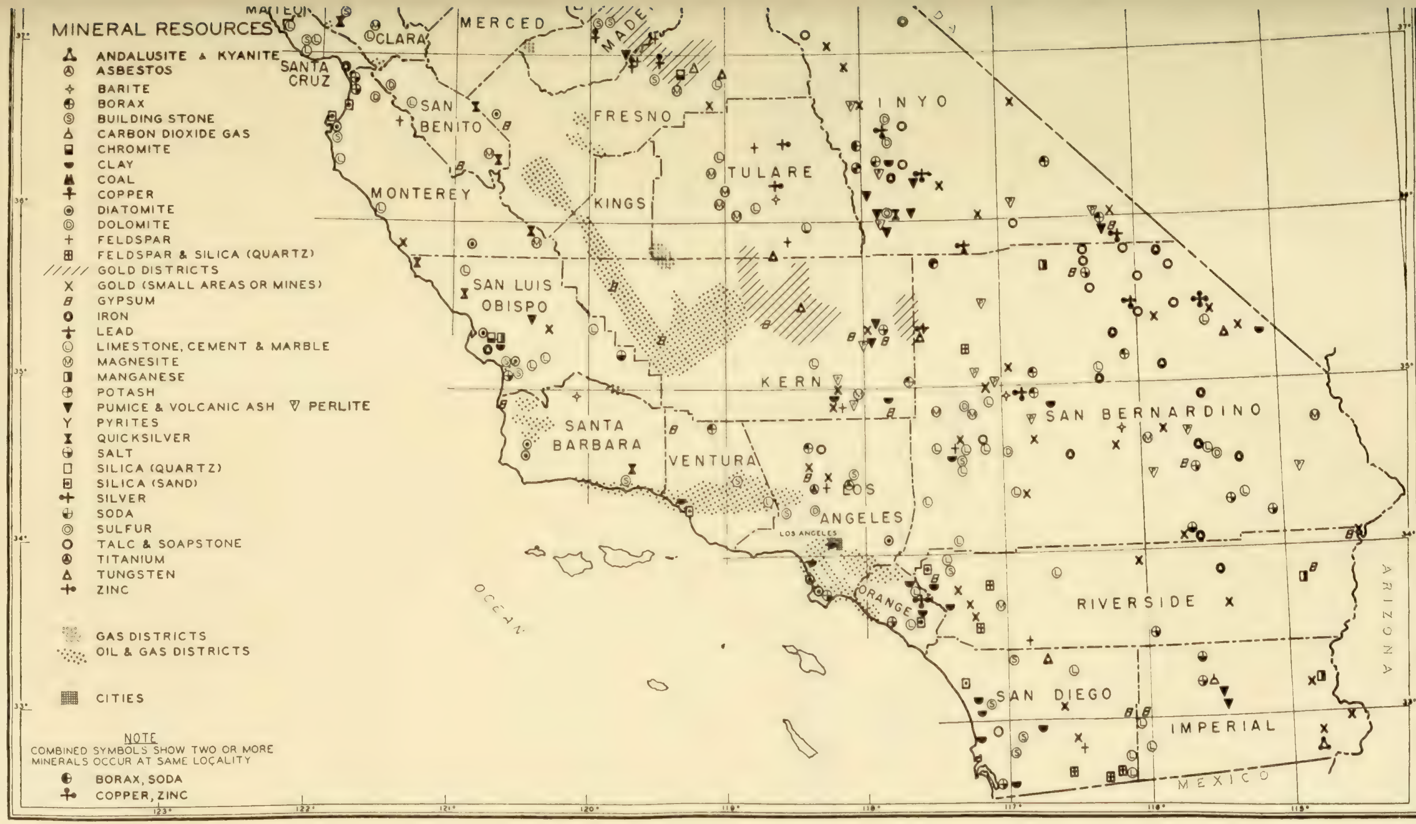
Branch Offices
State Building, 217 West First Street, Los Angeles 12
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
PACIFIC
DEL NORTE
SISKIYOU
MODOC
SHASTA
LASSEN
HUMBOLDT
TRINITY
REDDING
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
PLACER
MENDOCINO
COLUSA
YUBA
SUTTER
LAKE
YOLO
EL DORADO
ALPINE
SONOMA
NAPA
SOLANO
SACRAMENTO
AMADOR
CALAVERAS
MARIN
SAN FRANCISCO
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
NEVADA



MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY
BORAX, SODA
COPPER, ZINC
SANTA CRUZ
CLARA
MERCED
SAN BENITO
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN

CONTENTS

PLATES

MINES AND MINERAL RESOURCES OF YUBA COUNTY

By J. C. O'Brien *

OUTLINE OF REPORT

Illustrations

ABSTRACT

Yuba County, one of the first counties created in California, originally included Nevada and Sierra Counties, and part of Placer County. It now embraces 408,320 acres, much of which is privately owned, in the north-central part of California, extending eastward from the Feather River to the western slope of the Sierra Nevada. Agriculture is the principal industry, and the value of its products amounted to $9,799,000 in 1944.

The western half of the county is in the Sacramento Valley, and is covered by Recent alluvial deposits. Igneous rocks of the Sierra Nevada are associated with sediments in the eastern portion of the valley. Remnants of Tertiary andesitic lava lie on the eroded bedrock in the northeastern corner of the county, and in some areas the lava is underlain by Eocene auriferous gravel.

Gold has been the chief mineral produced. Value of the gold dredged from the Yuba River near Hammonton totals about 100 million dollars. Sand and gravel, excavated from bars and from dredge and hydraulic tailings along the Yuba River near Marysville, is second to gold in value. The recorded production of platinum and silver has been obtained during the refining of gold. Few gold quartz mines are active under the present adverse economic conditions.

INTRODUCTION

Geography. Yuba County was created February 18, 1850, as one of California's original 27 counties. At the time of its founding it included the present Nevada and Sierra Counties, as well as a portion of Placer County. These counties now form its eastern and southeastern boundaries, and it is bounded on the north and west by Butte and Sutter

* District Mining Engineer, State Division of Mines.

Counties. Yuba County embraces 408,320 acres, much of which is privately owned, although some 50,000 acres are included in National Forests, Camp Beale, and the Army airfield at Marysville.[1] According to the 1950 census, population of the county was 24,240, an increase of 42 percent over the 1940 count. The climate is warm and dry during the summer and the average winter rainfall ranges from 20 inches annually in the flat Sacramento Valley to nearly 70 inches in the northeastern corner of the county, where a heavy snow belt exists at an altitude of 5,000 feet. Marysville, the county seat and largest city, is the shipping and trading center for a large part of Yuba and adjoining Sutter County. Wheatland, 13 miles southeast of Marysville, is the center of a fruit-growing and dairying area and a shipping point for fruit, grain, and hogs.

Transportation. Yuba County has approximately 700 miles of roads, including 53 miles of state highway, 567 miles of local roads, and 51 miles of United States highways. The main line of the Western Pacific Railroad crosses the west end of the county, as does the east branch line of the Southern Pacific Railroad, which runs through Marysville to Roseville in Placer County. Freight service is provided to Sacramento by the Sacramento Northern electric trains.

Industries. Agriculture is the principal industry in Yuba County; the total value of all agricultural products in 1944 amounted to $9,799,000. Fruit and nut crops accounted for $3,293,800, peaches were the leading fruit crop, with a value of $1,426,245, and butterfat was the principal livestock product with a value of $1,259,360.

GEOLOGY *

Yuba County is a small tongue-shaped piece of land extending northeast from the vicinity of Marysville in Sacramento Valley to the vicinity of Camptonville in the Sierra Nevada. With the exception of the western borderlands, which are masked by valley and river terrace alluvium, most of the terrain of Yuba County has been developed on old crystalline rocks that make up the bulk of the Sierra Nevada. These are either acutely folded, strongly metamorphosed sedimentary and volcanic rocks of pre-Cretaceous age, or else granitic and peridotitic rocks intruded into them during the Upper Jurassic Sierran mountain building. The early Tertiary river deposits and the middle Tertiary fragmental volcanic rocks so commonly found above the early Tertiary gravels in some parts of the Sierras have been eroded from the Yuba County land surface for the most part; only scattered remnants are left.

One small area of upper Eocene marine rocks is exposed near Wheatland a few miles northeast of Marysville, and thin marine Eocene and Upper Cretaceous rocks presumably underlie the alluvium along the western border of the county. Small quantities of natural gas produced in Yuba County in 1925-26 probably came from these beds.

The pre-Cretaceous metamorphic rocks may conveniently be divided into two classes: a sparsely distributed sedimentary Paleozoic series called the Calaveras group, consisting mainly of rocks of marine origin,

[1] Beauchamp, M., and Perry, R., California Almanac and State Fact Book, 1948-49, California Almanac Company, p. 485.

* This section of the report has been prepared by Oliver E. Bowen Jr., Associate Mining Geologist, State Division of Mines.

including slate, quartzite, crystalline limestone, and mica schist, and a more widely distributed group of greenstones and green schists derived from flow and intrusive volcanic rocks. The stratigraphic position, and hence the age, of these green volcanic rocks have not been well established, but it is probable that both Mesozoic and Paleozoic series are represented. A few small limestone and manganese deposits are found in the metamorphosed Calaveras group sediments, but so far these have not been exploited. Calaveras group rocks are exposed in two narrow belts, both trending northwest: one passes across the county just east of Challenge and the other passes through Camptonville.

The intrusive granitic rocks of the Sierra Nevada batholith in Yuba County range in composition from granodiorite to gabbro, granodiorite greatly predominating. Preceding the various episodes in the emplacement of the Sierra Nevada batholith, less extensive invasions of diabase and rocks of the peridotite group took place. These peridotite rocks are almost invariably serpentinized and in some localities asbestos has been developed. Some serpentines also contain segregations of chromite, so that serpentine areas have particular economic significance. In Yuba County, serpentine rocks are confined to the area adjoining Challenge on the north.

A few of the many gold-bearing quartz veins in Yuba County have proven profitable to exploit, notably those in the Browns Valley, Challenge, and Dobbins districts. In addition, these and other quartz veins contributed to the auriferous gravels which have been so important in the development of Yuba County. These quartz veins also came into being during the Upper Jurassic Sierran mountain building, the fissures in which they formed having been created during the severe folding and faulting that preceded influx of the granitic rocks, and the vapors and solutions from which the gold was deposited having been segregated from the molten granites in their final stages of crystallization.

Auriferous gravels have been by far the greatest source of mineral wealth in Yuba County. More than $100,000,000 has been realized from them in the past, and about $2,000,000 in gold is still being produced annually. These deposits are also potential sources of enormous tonnages of sand, gravel, clay, and rock for construction industries, and small amounts of platinum-group metals are recovered from them each year.

The form, distribution, and character of the auriferous gravels are the results of a complex series of geologic events, the importance of which is not always recognized. Three general types of gravel deposits can be distinguished, each of which accumulated under a distinct set of conditions. The oldest gravels were laid down in the Eocene epoch in a tropical or near-tropical climate in which chemical decay was predominant. As a result, the rocks of the Eocene gravels tend to consist of chemically resistant materials, notably quartz pebbles derived from the wasting away of the gold-quartz veins. These old gravels were deposited by extinct river systems that were obliterated by fragmental volcanic materials thrown out onto the surface of the Sierra Nevada during the Miocene and Pliocene epochs. Parts of some of these old channels have been resurrected and exposed by erosion; others remain buried under volcanic caps and must be mined underground.

Table 1. Mineral production of Yuba County, 1880-1949.

Year	Amount, gold	Silver, value	Platinum		Miscellaneous stone, value	Miscellaneous and unapportioned		
			Ounces	Value		Amount	Value	Substance
1880	$943,860	$438						
1881	800,000	1,300						
1882	750,000							
1883	455,000							
1884	250,000							
1885	207,449							
1886	149,203							
1887	162,426							
1888	150,000							
1889	112,053	115						
1890	141,781							
1891	37,576							
1892	44,218							
1893	30,839							
1894	107,480							
1895	111,482							
1896	171,688							
1897	141,638							
1898	166,865							
1899	189,927	12						
1900	280,366	2,041						
1901	188,908	393						
1902	155,630	2						
1903	125,830	41						
1904	139,528					400 M	$3,000	Brick
						375 tons	750	Pottery clay
1905	324,135	369				400 tons	80	Pottery clay
						2,000 gals	800	Mineral water
1906	*	*				2,000 gals	800	Mineral water
1907	1,766,770	6,167				1,800 gals	720	Mineral water
1908	2,034,486	9,997			$5,570	1,000 M	10,000	Brick
1909	2,469,865	4,156			5,650	500 M	6,600	Brick
							568,564	Unapportioned
1910	3,204,273	5,372						
1911	2,997,072	5,299			9,318			
1912	2,753,408	6,198			15,526			

1913	2,491,505	7,571			8,063			
1914	2,800,713	5,295	74	$2,377	14,895			
1915	2,703,710	5,254	132	4,174	149,292			
1916	3,167,723	5,934	314	14,301	42,685	4,817 lbs	1,185	Copper
							6,000	Other minerals
1917	3,667,673	6,591	149	8,869	28,863			
1918	3,767,933	13,796	189	12,930	43,338		6,888	Other minerals
1919	4,195,732	12,276	125	13,098	40,439			
1920	3,467,769	16,502	113	14,395	74,943		40	Other minerals
1921	4,738,248	26,135	179	14,386	73,387		100	Other minerals
1922	2,492,948	8,222	115	11,077	75,969		100	Other minerals
1923	3,150,405	6,760	158	16,974	216,890		100	Other minerals
1924	1,995,434	4,461	73	8,733	181,113		100	Other minerals
1925	2,570,630	6,400	*		137,288		7,276	Natural gas, platinum
1926	2,769,703	6,398	*		133,298		11,695	Natural gas, platinum
1927	3,468,201	6,743			198,688		6,000	Other minerals
1928	2,304,377	4,910	*		202,708		17,081	Other minerals
1929	1,456,039	2,648	*		364,326		7,358	Other minerals
1930	968,814	1,255			*		48,330	Other minerals
1931	991,976	970	*		*		29,880	Platinum and miscellaneous stone
1932	960,749	915			27,485			
1933	1,117,844	1,179			31,930		9	Unapportioned
1934	1,911,960	2,938	*		31,099		5,049	Other minerals
1935	1,806,355	2,696			32,163		7	Other minerals
1936	2,847,530	3,460	*		37,922		4,911	Copper, platinum
1937	2,495,155	3,666			85,695		2,272	Other minerals
1938	2,461,935	5,397			163,628		2,178	Other minerals
1939	3,037,965	6,224			147,780		87	Other minerals
1940	3,885,875	7,345			134,819		7,575	Other minerals
1941	3,112,305	3,895			146,038	3,749	3,749	Other minerals
1942	2,645,825	3,627	*		589,034		6,285	Other minerals
1943	1,340,010	1,221	*		385,402		8,032	Other minerals
1944	974,855	922			130,484		50	Other minerals
1945	1,035,790	1,020			147,416		1,913	Other minerals
1946	2,029,685	2,724			238,182		2,515	Other minerals
1947	2,302,580	3,409			253,143			
1948	2,022,615	3,233			200,347			
1949	1,931,580	3,005			326,510			
Total	$118,931,753							

* See under Unapportioned.

During and immediately following the middle Tertiary volcanic period, new stream systems were developed that reworked and redeposited material in which rocks of both pre-volcanic and intervolcanic age are intermingled. In many cases this mixing of the old auriferous gravels with large volumes of volcanic ejecta resulted in deposits too lean in gold to be worth mining. Consequently, recognition of pre-volcanic and intervolcanic deposits has vital economic importance.

Since the close of the late Tertiary Sierran volcanic period, vast stream systems have been developed which have eroded still deeper the gold lodes formed in Upper Jurassic time, and to some extent robbed the old channel deposits and redeposited their gold. Most of the gold recovered from Yuba County placers during the past 50 years was deposited by the stream systems we see today, so that Recent river gravels, although they may be of lower grade, currently are of greater economic importance than the less extensive and more inaccessible early Tertiary gravels.

The structure of the stratified rocks of the basement complex (commonly called the Subjacent series) in Yuba County has never been adequately worked out. Structure sections in folios of the U. S. Geological Survey, now 50 or more years old, indicate greater volumes of metamorphosed intrusive volcanic rock than are recognized today. They also show an unbroken series of stratified rocks that in general dip steeply to the east and strike N. 25° W. More recent investigations in the Sierra Nevada indicate that the apparent tilted or homoclinal attitude of the beds may be the result of isoclinal folding, position of the fold axes not being readily recognizable because fold crests have been eroded off and fold troughs deeply buried, because of the diverse, non-persistent lithology of the section, and because of the parallelism of fold axes and fold planes.

With the exception of the old river channel deposits which may trend in almost any direction, structures in the late Cretaceous, Tertiary, and Quaternary rocks invariably are gently homoclinal with dips toward the west. Such rocks always lie in marked unconformity upon the acutely folded basement rocks and are commonly called the Superjacent series. Where Recent stream erosion has exposed cross sections and bedrock profiles of the Tertiary channels, some idea of their complex history may be had.

MINERAL RESOURCES

Auriferous gravels dredged along the Yuba River in the vicinity of Hammonton have yielded gold valued at approximately $100,000,000 since dredging started in 1903; these gravels remain the chief source of mineral wealth in Yuba County. The Yuba Consolidated Gold Fields operates five bucket-line dredges in the Hammonton area, each employing 22 to 25 men. About 100 additional men are employed in the company's shops at Hammonton.

There is a little activity at gold quartz mines in Browns Valley and in the Dobbins district. Silver, platinum, and some of the platinum group metals are recovered as by-products of gold mining.

Prior to 1947 there was a small, irregular production of brick clay, pottery clay, mineral water, copper, and natural gas, but none of these substances have been produced since that time. Asbestos and soapstone prospects have been found, but they are small and distant from markets.

Deposits of limestone are exposed in the narrow belt of Carboniferous rocks that extends northwestward across the extreme eastern side of the county, but these are too remote to be economically worked at present. Dollar value of the sand and gravel recovered from tailing piles and used for aggregate and road material is second only to gold.

Descriptions of idle mineral deposits included in this report are taken from earlier publications of the California Division of Mines. Many of the properties listed have been idle for many years, and are probably abandoned.

Gold

The *California Mother Lode* or *Eagle gold mine* includes the Eagle, Golden Age, Pennsylvania, Mother Lode Fraction, Apex Lode, Frisco Fraction, California, Beverly and Ora Fina unpatented mining claims in sec. 19, T. 18 N., R. 7 E., M. D. The property is owned by Clara B. Worthington and was leased to the California Liberty Mines Company, Incorporated, on July 5, 1949. Floyd J. Wilson, 722 University Building, Denver, Colorado, is president of the company, and Vernon Cox is general superintendent.

Five men are employed sinking a two-compartment vertical shaft in the hanging wall of the vein on the Eagle claim about 250 feet east of the old caved inclined shaft. The company plans to sink to the 300-foot level and crosscut west about 130 feet to the vein. The shaft was sunk through granitic rock for 150 feet from the surface, and a pump station was cut at that level. The shaft was 262 feet deep on March 22, 1951, and a 3-inch wide quartz and calcite stringer showing some free gold associated with fine pyrite had just been cut. The quartz stringer is banded and is enclosed in a fine-grained gray diabase with lenses of coarse hornblende and pyrite. The old mine workings are now flooded, but maps and records indicate that south of the shaft on the 300-foot level, the vein is 10 feet wide, strikes N. 15° E., and dips 80° E.

The *Dannebroge mine* is located on patented land in Browns Valley in the SE¼NE¼ sec. 16, T. 16 N., R. 5 E., M. D., and is owned by the Empire Star Mines Company, Limited, Box 1027, Grass Valley, California. The property has been leased and operated by a partnership including George Little, M. R. Smethurst, Rexford Holt, and Clair Hoxforth, since February 1949. The partners work the mine with the help of one man. The mine is developed by an incline shaft 1,000 feet deep and a winze 500 feet deep, the latter located 200 feet east of the shaft on the 1,000-foot level. The vein ranges from 6 inches to 8 feet in width, averages about 30 inches, has an average strike of N. 35° W., and dips 25° N. Gold, associated with galena and pyrite, occurs in a quartz vein; the wall rock is greenstone. Present work by the partners is on the 1,300- and 1,500-foot levels. The vein is drilled with stoper and drifter drills and the broken ore is pulled to loading chutes with slushers operated by air hoists. The walls are supported by pillars and stulls and stopes are backfilled. Ore mined by the lessees is hauled by trucks to the Pennsylvania mine mill about a quarter of a mile south.

Two mill men from the Empire Star mine at Grass Valley operate the mill 5 or 6 days each month. The ore is crushed to ⅜-inch in a Symons cone mill and ground to 200-mesh in a Hardinge ball mill. Free gold is recovered by amalgamating jig and table concentrates and a flotation

Yuba Consolidated Gold Fields, Yuba County operations data.

Dredge number	Year operations started	Hull dimensions			Number buckets on line	Digging depth (below water level)	Electrical power requirements	Gold recovery method	Amount of gravel washed per year (cubic yards)
		Width	Length	Depth					
15	1916	68	165	12	96	85	975	Sluice boxes with Hungarian riffles (rubber)	3,900,000
17	1934	68	234	12	122	120	1,575	Sluice boxes with Hungarian riffles (rubber)	3,900,000
18	1919	68	165	12	96	77	975	Sluice boxes with Hungarian riffles (rubber)	?
19	1925	75	156	12	88	70	975	16 Pan American jigs	4,300,000
20	1939	80	251	12	132	120	2,175	16 Yuba jigs	4,400,000
*14	1913	58	155	12	92	*90	975	Sluice boxes with Hungarian riffles (rubber)	3,500,000

* Dredge No. 14 dismantled in 1951. At time of shutdown, the dredge was digging 40 feet below water level.

concentrate is recovered from the tailing. Mill tailing is piped to the Jefferson mine shaft and used to fill old workings in that mine. Production amounts to about 250 tons per month.

The *Yuba Consolidated Gold Fields* has six bucketline dredges on the Yuba River in the vicinity of Hammonton. Dredging was started in this area in 1903 by W. P. Hammon and R. D. Evans who organized the company in 1905. The company owns a total of 11,129 acres of patented land along the Yuba River near Hammonton, of which 6,574 acres is classified as tailing and river bars, 1,063 acres as agricultural land, and 3,492 acres as pasture land. Dredging conditions are good as the gravel is generally medium to fine and contains no troublesome boulders. The gravel includes cobbles and pebbles of gabbro, diorite, and quartz.

The dredges dig to the limit of their digging ladder or to the economical depth, which varies from place to place. Dredges 17, 19, and 20 are equipped with hydraulic monitors which are used to wash high banks into the dredge pond. Constant improvement in equipment and design has made it profitable to rework some of the old tailing piles a third time. Dredges 18 and 20 are now reworking tailings. The dredges are all built on steel hulls and each has buckets with a capacity of 18 cubic feet. The trommel screens are 9 feet in diameter and from 30 to 50 feet long.

Crews of 22 to 25 men are employed on each dredge, and average between 20 and 21 hours working time a day per dredge. Yuba Consolidated Gold Fields employ 250 to 260 men in their dredging operations and shops, and have a payroll of over $1,000,000 per year in California. They have an office at 351 California Street, San Francisco, and a field office at Hammonton.

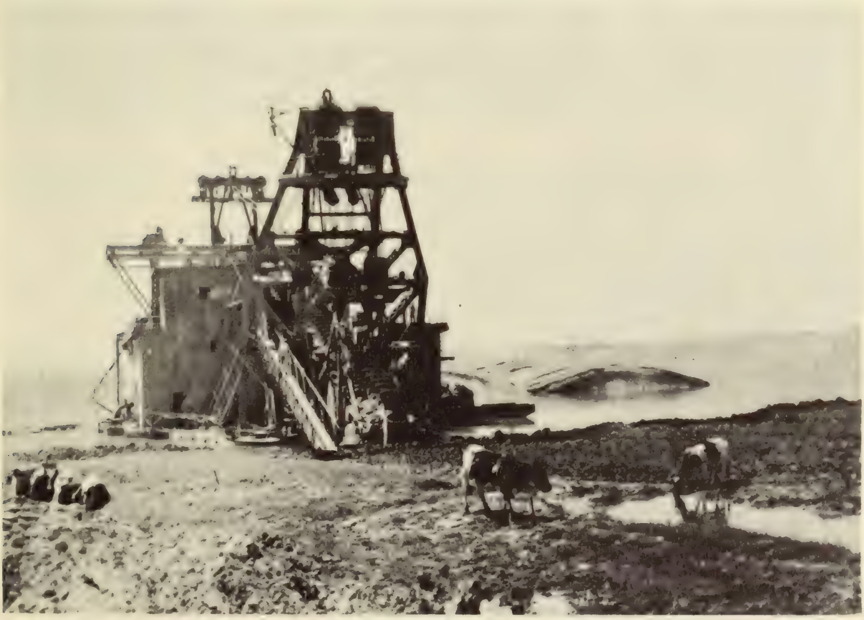


FIGURE 1. Yuba Consolidated Gold Fields dredge No. 19.

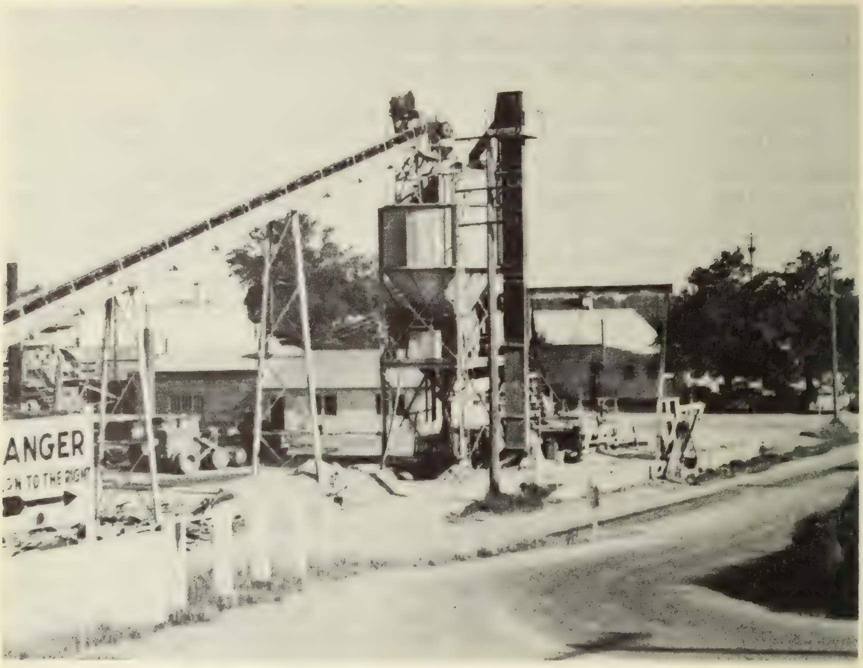


FIGURE 2. Rice Bros. aggregate plant, Marysville.

Manganese [2]

Two small manganese deposits occur in the northeastern corner of Yuba County. Each consists of rhodonite in slightly recrystallized chert, which forms part of the metamorphic basement complex. The depth of oxidation is slight. There is no production recorded from these deposits. The following descriptions are quoted from Division of Mines Bulletin 152.

Bean Prospects [3] (by Ivan F. Wilson, August 1, 1942). Several prospects east of Clipper Mills were shown the writer by Rufus J. Bean of Clipper Mills. Part of these are in an old hydraulic gold property known as the Kingbird mine and located in sec. 36, T. 20 N., R. 7 E. The mineral rights of this property are owned by a Dr. Martell of Philadelphia. An adjacent prospect to the west owned by Rufus J. Bean is in sec. 2, T. 19 N., R. 7 E., M.D. The properties are 0.2 to 0.5 mile east of Clipper Mills, between the highway and Grizzly Creek to the north. The nearest railroad is 28 miles west at Oroville on the Western Pacific Railroad. No development for manganese has been done on the properties.

The Kingbird, an old hydraulic gold placer deposit beneath a lava cap, exposes large boulders of vein quartz and fine-grained quartzite, which probably is metachert. Some of these boulders of metachert contain manganese oxides. There are no minable masses of shipping grade, however.

[2] Manganese in California: California Div. Mines Bull. 125, pp. 92, 208, 1943.
[3] Trask, Parker D., and others, Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, pp. 347-348, 1950.

Along Grizzly Creek to the northwest the metachert is in place. It has been recrystallized to fine-grained white quartzite, and is enclosed in fine-grained gray schist and phyllite, probably of Calaveras age. The metachert contains stains and stringers of manganese oxides, but no material in sight is of economic value.

Assays made by the U. S. Bureau of Mines of samples from this property showed the following results:

Mn	*Fe*	*SiO_2*	*P*
		Percent	
2.0	1.98	89.12	.104
7.6	34.42	29.68	.481

No. 2 Clemens Prospect (by N. L. Taliaferro, September 9, 1918). The Clemens prospect is in sec. 29, T. 19 N., R. 7 E., and is said to be controlled by Fred Clemens of Woodleaf. The deposits consist of oxidized rhodonite exposed over an area 15 feet long and 1 foot to 3 feet wide. The manganese content is about 10 percent. The property is undeveloped.

Sand and Gravel

The *Hallwood gravel plant* is on the north bank of the Yuba River, 1 mile east of Marysville, at the end of Plantz road. It was operated by G. C. McKenzie of Yuba City until the summer of 1950, when it was taken over by Rice Brothers, Inc. The gravel consists of hydraulic mine tailing and includes pebbles of diabase, diorite, and quartz. Few pebbles are over 2 inches in size. The material is dug with a dragline equipped with a 1¼-yard bucket, to a clay stratum at a depth of about 4 feet. Dump trucks holding 5 cubic yards each haul the material about a quarter of a mile to the screening plant. The material is dumped into a wooden bin from a ramp and drawn through a gate on the bottom onto a belt conveyor which discharges it over a double-deck shaking screen. The material is washed with water sprays above the screen and separated into minus 1½-, minus 1-, and minus ¼-inch sizes, which slide into appropriate bins. The sand is dewatered in a spiral classifier. Stock piles of the screen products are maintained on the site. Delivery trucks can be loaded directly from the bins or from stock piles with a dragline equipped with a ½-yard bucket. The material is used for concrete aggregate, mortar, and stucco.

The *Marysville Rock Products Company* pit is located on the north bank of the Yuba River near the east city limit of Marysville on land leased from Rice Brothers, Inc. It is operated intermittently by W. G. Davis of Marysville, who also operates a gravel pit on Dry Creek in Butte County. The sand and gravel is dug to a depth of 6 to 8 feet with a 12-yard LeTourneau Carryall which is pulled by a D-8 Caterpillar tractor. Crushing and screening is done with a Model 100 Austin-Western portable screening plant. Standard sizes of sand and gravel are stock piled and sold for use in building roads and for concrete aggregate. Much of the output is used in making concrete pipe. Dump trucks are loaded from the stock piles with a Hough Payloader fitted with a ¾-cubic-yard bucket. One man is employed loading trucks from stock piles and making deliveries in the Marysville district.

Rice Brothers, Incorporated, purchased the Hallwood gravel plant in the summer of 1950 and built a new screening plant on that site with

equipment taken from their old plant which was located about 8 miles east of Marysville. Another screening plant is located at a dredge tailing pile in sec. 35, T. 16 N., R. 4 E., M.D. Here the material is pushed into a hopper with a bulldozer and fed into a Pioneer portable crushing and screening plant. The minus 1-inch product from this plant is used at the Rice Brothers asphalt road-mix plant and a Blaw-Knox concrete batching plant which are located in Marysville. Stock piles of standard size materials are maintained at both sites, from which trucks are loaded with a dragline fitted with a quarter-yard clamshall bucket. The screening plant has a capacity of 120 tons per hour. Delivery trucks loaded with sand or gravel are weighed on a platform scale. The concrete batches are delivered with five transit-mix trucks of 4-cubic-yard capacity. Rice Brothers operate a fleet of fifteen 5-cubic-yard and seven 10-cubic-yard capacity trucks hauling sand and gravel in the Marysville district.

The *Yuba River Sand Company* plant is located on the levee of the Yuba River at the foot of B Street in Marysville. Sand and gravel is pumped from the bed of the river with an 8-inch centrifugal pump driven by a 150-horsepower motor. The pump is mounted on a steel hull made by joining two navy landing barges in tandem. A revolving spiral cutter 31 inches in diameter and 4 feet long revolves at 14 revolutions per minute ahead of the suction screen, and, together with two water jets, agitates the sand and gravel around the 2-inch-mesh screen. The pump delivers 2,200 gallons of water per minute, which includes 10 to 14 percent solids, through 450 feet of 8-inch-diameter spiral steel pipe to the screening plant. The pipe is floated on navy surplus life rafts. Reinforced rubber hose is used in place of pipe-bends and elbows.

The pulp, of which 90 percent is sand, is dewatered in classifiers. The plus ¼-inch material is separated by shaking screens into standard concrete-aggregate sizes. Some of the ⅝-inch-mesh material is crushed by a set of 24-inch-diameter rolls to produce additional sand when needed. Stock piles of concrete aggregate, roofing granules, and plaster, filter, and sandblasting sand are maintained. Railroad cars and trucks can be loaded from storage bins or from stock piles by a dragline fitted with a clamshell bucket. The plant has a capacity of 100 tons of washed and screened material per hour and is operated one shift by a crew of 6 to 10 men.

BIBLIOGRAPHY

Allen, John Eliot

41 Geological investigation of the chromite deposits of California: California Div. Mines Rept. 37, pp. 101-167, 1941

Allen, Victor T.

29 The Ione formation of California: Univ. California Pub. Geol., vol. 18, no. 14, pp. 347-448, 1929.

Aubury, Lewis E.

05 The copper resources of California: California Min. Bur. Bull. 23, 282 pp., 1905.

06 Structural and industrial materials of California: California Min. Bur. Bull. 38, 412 pp., 1906.

08 The copper resources of California: California Min. Bur. Bull. 50, 366 pp., 1908.

Averill, C. V.

46 Placer mining for gold in California: California Div. Mines Bull. 135, 377 pp., 1946.

Bowen, Oliver E. Jr.
49 Yuba County: California Div. Mines Bull. 142, pp. 144-145, 1949.

Clark, B. L., and Anderson, C. A.
38 Wheatland formation and its relation to early Tertiary andesites in the Sierra Nevada: Geol. Soc. America Bull., vol. 49, pp. 931-956, 1938.

Crawford, J. J.
94 California Min. Bur. Rept. 12, 412 pp., 1894.
96 California Min. Bur. Rept. 13, 726 pp., 1896.

Dietrich, Waldemar F.
28 The clay resources and ceramic industry of California: California Div. Mines and Mining Bull. 99, 383 pp., 1928.

Eric, John H., et al.
48 Copper in California: California Div. Mines Bull. 144, 429 pp., 1948.

Jenkins, Olaf P.
32 Geologic map of the northern Sierra Nevada and accompanying report: California Div. Mines Rept. 28, pp. 279-298, 1932.

Jenkins, Olaf P., et al.
43 Manganese in California: California Div. Mines Bull. 125, 387 pp., 1943.
49 Counties of California: California Div. Mines Bull. 142, 197 pp., 1949.

Lindgren, Waldemar, and Turner, H. W.
95 U. S. Geol. Survey Geol. Atlas, Marysville fol. (no. 17), 1895.
95a U. S. Geol. Survey Geol. Atlas, Smartsville fol. (no. 18), 1895.

Logan, C. A.
19 Platinum and allied metals in California: California Min. Bur. Bull. 85, 120 pp., 1919.
20 Auburn district, Yuba County: California Min. Bur. Rept. 17, p. 490, 1920.
22 Auburn field division: California Min. Bur. Rept. 18, pp. 606-608, 1922.
24 Sacramento field division: California Div. Mines Rept. 20, p. 84, 1924.
30 Yuba County, Sacramento field division: California Div. Mines Rept. 26, pp. 186-201, 1930.
31 Sacramento field division: California Div. Mines Rept. 27, pp. 246-261, 1931.
35 Review of gold mining in east-central California: California Div. Mines Rept. 31, pp. 1-23, 1935.
42 Mineral resources of Sierra County: California Div. Mines Rept. 38, pp. 7-67, 1942.

Pask, Joseph A., and Turner, Mort D.
Geology and ceramic properties of the Ione formation, Buena Vista area, Amador County, California: California Div. Mines Special Rept., in press.

Preston, E. B.
90 Yuba County: California Min. Bur. Rept. 10, pp. 795-803, 1890.

Trask, Parker D., et al.
50 Geologic description of the manganese deposits of California: California Div. Mines Bull. 152, pp. 347-348, 378, 1950.

Turner, H. W.
96 Further contributions to the geology of the Sierra Nevada: U. S. Geol. Survey Ann. Rept. 17, pt. 1, pp. 571-776, 1896.
98 U. S. Geol. Survey Geol. Atlas, Bidwell Bar fol. (no. 43), 1898.

Waring, Clarence A.
16 Yuba County: California Div. Mines and Mining, Rept. 15, pp. 418-459, 1919.

Winston, W. B., and Janin, C.
10 Gold dredging in California: California Min. Bur. Bull. 57, 312 pp., 1910.

TABULATED LIST OF MINES AND PROSPECTS IN YUBA COUNTY

The following list of mines and prospects in Yuba County is arranged alphabetically by commodity and by name of prospect or mine. Numbers which appear in the left-hand column under the heading *Map No.* refer to the *Map showing mines and prospects of Yuba County, California*, plate 6. References cited under the heading *Remarks* (Waring, C. A., 16, p. 424) refer to the bibliography which accompanies this report.

ASBESTOS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Butte County Pine and Hardwood Co.		8?	19N	7E	M.D.	White slip fiber amphibole asbestos occurs irregularly along a serpentine-slate contact (Waring, C.A. 16, p. 424) in a 20-ft. prospect shaft, half a mile below the Mount Hope mine near the road to Oroville. Idle.
	Kingbird drift mine	Bean & Nieland, Clipper Mills	36	20N	7E	M.D.	Very small seams in serpentine. (Logan, C.A. 30, p. 190; 31, p. 250; Waring, C.A. 16, p. 424)
	Mount Hope		8	19N	7E	M.D.	Small seams along a serpentine-slate contact. (Aubury, L.E. 06, p. 264; Waring, C.A. 16, p. 423)
	Galena Hill	W.S. and M.E. Godfrey, Camptonville	SW$\frac{1}{4}$ 35	19N	8E	M.D.	Small seams in serpentine exposed in an old hydraulic pit. (Aubury, L.E. 06, p. 265; Waring, C.A. 16, p. 423)

BAUXITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Dempsey Ranch	J.F. Dempsey (1915)	3	15N	6E	M.D.	Analyses of samples taken from the deposit have proved it to be a white silicious clay. (Aubury, L.E. 06, p. 264; Waring, C.A. 16, p. 424)

CLAY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Dempsey Ranch	J.F. Dempsey (1915)	3	15N	6E	M.D.	A silicious white clay was taken from a tunnel and shipped to Oakland. (Dietrich, W.F. 28, p. 235; Waring, C.A. 16, p. 424)
	Durst Ranch		10,12 18	14N	5E	M.D.	Six feet of black clay loam is overlain by 18 in. of soil. Used for tempering pottery clay. (Aubury, L.E. 06, p. 230; Dietrich, W.F. 28, p. 236; Waring, C.A. 16, p. 424)
	Marysville Brick Co.						Located a short distance north of Marysville on the Feather River. Local surface clay was used to make common brick. (Dietrich, W.F. 28, p. 236)

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Ayer		35	16N	5E	M.D.	Now included in Camp Beale boundaries. A 3-ft. quartz vein with pyrite and chalcopyrite. Idle. (Eric, John H. 48, p. 357; Waring, C.A. 16, pp. 424-425)
	Brady Ranch (Old Red Ledge)		1 35	15N 16N	5E 5E	M.D. M.D.	Now included in Camp Beale boundaries. The water from an old shaft is impregnated with copper; extensively exploited in 1863. Idle. (Aubury, L.E. 05, p. 172; 08, p. 205)
	Dempsey Ranch	John Dempsey (1915)	3	15N	6E	M.D.	Gossan and surface "indications" 400 ft. wide; 100-ft. adit. Little exploration. Idle. (Aubury, L.E. 05, p. 171, 08, p. 205)
	Paul Copper	S.F. Paul, Marysville (1918)	Appx.	16N	6E	M.D.	Idle. (Eric, John H. 48, p. 357)

GOLD

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
1	Abbie (Manzanita)		SE$\frac{1}{4}$28	19N	6E	M.D.	An 8-ft. wide quartz porphyry vein along contact of diorite and slate; 300-ft. shaft; 60-ft. tunnel; 195 feet of drifts. Idle. (Waring, C.A. 16, p. 451)
	Abbott	N.B. Abbott, Rackerby (1915)	SW$\frac{1}{4}$8	18N	6E	M.D.	A 3-ft. wide quartz vein; two compartment shaft 65 ft. deep on vein dipping 70° NW. Some ore milled at Santa Rosa mine yielded $5.00 per ton. Carried 5 percent sulphides Idle since 1906. (Waring, C.A. 16, p. 443)
	Albion King	W.B. Ross, Waldo (1915)	33	15N	6E	M.D.	A 2-ft. wide quartz vein along contact of porphyry with slate; open cut 40 ft. Idle. (Waring, C.A. 16, p. 443)
	Alcalde placer	W.R. Hendricks, Browns Valley (1915)					On Yuba River 8 mi. NE of Browns Valley. Idle. (Waring, C.A. 16, p. 441)
	Alice Cady						Yuba River district. Production reported by George Weaver of Forbestown in 1950.
	Arbucco		16	19N	7E	M.D.	A 3-ft. wide vein of ribbon quartz along a contact of serpentine with granite; workings caved. Idle. (Waring, C.A. 16, p. 443)
	Archimedes placer	E.A. Forbes, Browns Valley (1915)	20,21	16N	6E	M.D.	A river claim in hydraulic tailings worked with sluice boxes. Idle. (Waring, C.A. 16, p. 441)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	B. A. C.		26	16N	6E	M.D.	A 4-ft. wide quartz vein in diabase with free gold; 250-ft. incline shaft; five-stamp mill. Idle. (Logan, C.A. 22, p. 606; Waring, C.A. 16, p. 443-444)
	Barton, (Boston Hill, Neversweat)	L.J. Adams, et al.	$E\frac{1}{2}NE\frac{1}{4}$ 36	20N	7E	M.D.	A drift mine; coarse gravel overlain by andesite; tunnels 900 and 300 ft. long. Idle. (Waring, C.A. 16, p. 438)
	Bates, A.C.		35?	19N	6E	M.D.	Two parallel ledges 300 ft. apart; 110-ft. shaft on vein with 10-ft. drift at 100-ft. level. An adit driven 142 ft. east is estimated to be 125 ft. from a second vein. Bates claimed to be making wages milling a few hundred pounds of ore per day in a high-speed perpendicular arrastra driven by a water wheel. Idle. (Logan, C.A. 22, p. 606)
	Bean Boys (Kingbird)	Bean & Nieland Inc., Clipper Mills	$SW\frac{1}{4}1$	19N	7E	M.D.	Gravel 10 to 12 ft. wide in a branch of North Fork of Yuba River. Idle. (Logan, C.A. 22, p. 606; 30, p. 197; 31, p. 258; Waring, C.A. 16, p. 439)
	Beaver (Union, Cassa, or Golden Mary)		$W\frac{1}{2}34$	19N	6E	M.D.	Ribbon quartz vein 3 to 6 ft. wide dipping west; granite and slate walls; incline shaft 28 ft. deep; free gold with small amount of iron and copper sulphides. Idle. (Crawford, J.J. 94, pp. 319-320; 96, p. 500; Waring, C.A. 16, p. 445)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
2	Beehive (Mount Hope)	M.A.G. Blake estate, c/o G.A. Phillips, 608 East 22d St., Oakland	NE¼ SW¼ 18	19N	7E	M.D.	Quartz vein 2 to 12 ft. wide is developed by an incline shaft 100 ft. deep with levels at 50 and 100 ft. Stoped to surface from 50-ft. level for a length of 400 ft. Idle. (Crawford, J.J. 94, p. 317; 96, p. 501; Logan, C.A. 30, p. 188; 31, p. 249; Waring, C.A. 16, p. 444)
	Beik prospect						See Mount de Oro
	Bessie	Annie Burris Browns Valley	16	16N	5E	M.D.	A 3-ft. quartz vein carried some free gold in places; 40-ft. incline shaft; 100 ft. of drifts. Idle. (Waring, C.A. 16, p. 445)
	Big Ledge (Little Kingbird)						See Little Kingbird
	Bismark prospect		33	15N	6E	M.D.	Tunnel 550 ft. long. Idle. (Waring, C.A. 16, p. 445)
	Black Maria and Marc Anthony	Alvina Gunning, c/o Alvina E. Geraghty, 231 Briar Lane, San Mateo	E½SE¼ 20	16N	6E	M.D.	An 18-in. wide quartz vein in slate; 40-ft. shaft; 175 ft. of drifts. Idle. (Preston, E.B. 90, pp. 797-798; Waring, C.A. 16, p. 445)
	Blue Gravel	Interstate Holding Co., Marysville	27,28 34	16N	6E	M.D.	Idle. (Waring, C.A. 16, p. 445)
3	Blue Point	Rosebar Development Co., Box 413, Smartsville	27	16N	6E	M.D.	A part of Smartsville hydraulic mine worked by drifting cement gravel was worked in three arrastras. Idle. (Crawford, J.J. 94, pp. 317-318; 96, p. 499; Logan C.A. 35, pp. 7-8)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Boa prospect		29	16N	6E	M.D.	A 4-ft. wide quartz vein in slate carries sulphides. Idle. (Crawford, J.J. 96, p. 499; Waring, C.A. 16, p. 445)
	Boston Consolidated						Placer property including the Boston Boy and other claims along Yuba River northeast of Browns Valley. Idle. (Waring, C.A. 16, p. 442)
	Boston Hill (Barton, Neversweat)	L.J. Adams et al.	E½NE¼ 36	20N	7E	M.D.	A drift mine; coarse gravel overlain by andesite; 900-ft. tunnel and 300-ft. tunnel. (Waring, C.A. 16, p. 438)
	Bright Star		20	16N	6E	M.D.	Claim in Yuba River bed. Idle. (Waring, C.A. 16, p. 442)
	Buckhorn placer						Dobbins district. Operated by W.P. Phillips of North San Juan, California, in 1950.
	Bullard's Bar prospect	Pacific Gas & Electric Co.	NW¼13	18N	7E	M.D.	Eighty-five ft. quartz vein along contact of granite and slate; 15-ft. shaft; tunnel 155 ft. Idle. (Waring, C.A. 16, p. 446)
	Burns prospect		27?	16N	6E	M.D.	A 3-ft. wide quartz vein in slate; 50-ft. shaft; 200-ft. tunnel. Idle. (Crawford, J.J. 96, p. 499; Waring, C.A. 16, p. 446)
4	California Mother Lode (California Liberty, Eagle, Golden Age)	Clara B. Worthington	18,19	18N	7E	M.D.	A 3-ft. wide vein along a slate-diabase contact. Sinking a new shaft in 1951. Leased to Liberty Mines Co., 722 University Bldg., Denver, Colo. (Logan, C.A. 30, p. 186; 31 p. 248; Waring, C.A. 16, p. 446; herein)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Chandler	August Eymard, Browns Valley (1915)	22	16N	5E	M.D.	160 acres patented land; rich pocket was mined from a 30-ft. vertical shaft about 1886. Idle. (Crawford, J.J. 94, p. 318; 96, p. 499; Waring C.A. 16. p. 447)
	Clarks		N$\frac{1}{2}$26	19N	6E	M.D.	A 30-in. wide vein developed by an incline shaft 100 ft. deep, and 600 ft. of drifts. Ore treated in a Huntington mill; amalgamated concentrates from shaking table shipped to Selby smelter. Idle. (Preston, E.B. 90, p. 799-801)
	Cleopatra	Alvina Gunning, c/o Alvina E.Geraghty, 231 Briar Lane, San Mateo	28,29	16N	6E	M.D.	4-ft. wide quartz vein in diorite; 45-ft. shaft. Patented. Idle. (Crawford, J.J. 96, p. 499; Waring, C.A. 16, p. 447)
	Cleveland placer		15	16N	6E	M.D.	Idle. (Preston, E.B. 90, p. 798-799)
	Conwell prospect		23	18N	7E	M.D.	1$\frac{1}{2}$ miles NW of Brownsville. Idle. (Waring, C.A. 16, p. 447)
	Dakota						A 3-ft. wide vein between rotten slate walls. Idle for many years. (Crawford, J.J. 94, p. 319; 96, p. 499; Waring, C.A. 16, p. 447)
5	Danneborg	Empire Star Mines Co., Ltd., Box 1027, Grass Valley	NE$\frac{1}{4}$ SE$\frac{1}{4}$ 16	16N	5E	M.D.	Patented. A quartz vein 30 in. wide; free gold, pyrite, and chalcopyrite. Developed to a depth of 1500 ft. Producer. (Crawford, J.J. 94, p. 318; 96, p. 499; Preston, E.B. 90, p. 798; Waring, C.A. 16, p. 477; herein)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
6	Deadwood (Miller)	Catherine Fry, H. M. Richards, Pearl Black, W.D. Cox, E.B. Fry, et al., Box 281, Chico	15,16,	19N	6E	M.D.	A 5-ft. wide quartz vein developed by several shallow shafts. Idle (Crawford, J.J. 96, p. 499; Waring, C.A. 16, p. 449)
	Deer Creek (Enterprise, Pittsburgh, and Smartsville Consolidated placers)	Interstate Holding Co., 409-4th St., Marysville	SE¼27 SE¼ SE¼28	16N	6E	M.D.	An old hydraulic mine. Idle. (Waring, C.A. 16, p. 439)
	Depot Hill						See Joubert.
	E.M. & E. placer	Mrs. E.M. Macey, Box 52, Cedar Ridge					In the Smartsville district. Producer in 1950.
	Eagle						Six miles SE of Brownsville. A quartz vein developed by a long adit now caved; decomposed surface material was run through a five-stamp mill; some pyrite. Idle. (Crawford, J.J. 94, p. 318)
	Eagle Delle	Associated Miners, Strawberry Valley (1935)	20,21	20N	8E	M.D.	Idle. (Eric, J.H. 48, p. 357)
	Eagleville (North Star)						See North Star
7	Easy Money prospect	John M. & Richard W. Tatum, c/o C.A. Tatum, Challenge, Calif.	SW¼ NW¼17	19N	7E	M.D.	Idle. (Logan, C.A. 30, p. 189; 31, p. 249; Waring, C.A. 16, p. 448)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Eich prospect		?	17N	6E	M.D.	Near Oregon House. An 18-in. quartz vein outcrops for a length of 300 ft; 10-ft. shaft; 680 acres patented. Idle. (Waring, C.A. 16, p. 449)
	Enterprise						See Deer Creek
	Fairview prospect		9	16N	5E	M.D.	A 3-ft. wide quartz vein carrying free gold; 35-ft. shaft; 30-ft. drift. Idle. (Waring, C.A. 16, p. 448)
	Fillmore Hill	S.O. Gunning, Marysville	SE$\frac{1}{4}$ SW$\frac{1}{4}$29	16N	6E	M.D.	Idle. (Waring, C.A. 16, p. 442)
	Forbes placer	E.A. Forbes, Browns Valley	8,10 11,14 15,16 17	16N	6E	M.D.	Idle. (Waring, C.A. 16, p. 442)
	Forsyth						Operated by Roy Gardner, Rt. #3, Box 73, Orland, California, in 1950.
	Garbet prospect		4?	18N	6E	M.D.	A 2-ft. quartz ledge said to mill $6.00 per ton. Idle. (Waring, C.A. 16, p. 448)
	George prospect		17	18N	7E	M.D.	160-acre patent. A 30-in. quartz vein in granite carrying free gold and pyrite. 14-ft. shaft. Idle. (Logan, C.A. 22, p. 740; Waring, C.A. 16, p. 448)
	Georgia Gulch		?	20N	8E	M.D.	Operated by Harold Brun, Strawberry Valley, in 1950.

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Gold Dredges, Inc., Ltd. (Garden Valley dredger)		8?	18N	8E	M.D.	Operation closed July 1, 1930. (Logan, C.A. 30, p. 193-195; 31, p. 255)
	Golden Age						See California Mother Lode. Sinking new shaft in 1950.
8	Golden Arrow (Old Spanish)	O.N. Pauley & W.J. Mellon Estate, Challenge, California	$NW\frac{1}{4}$ $NE\frac{1}{4}$ 32	19N	6E	M.D.	Old surface excavation 50 ft. deep and 2000 ft. long on a vein up to 3 ft. wide; an adit 300 ft. long on the vein, 90 ft. below surface. Idle. (Logan, C.A. 22, p. 607)
9	Golden Gate	Edward Bickel, c/o Yolo Development Co., 1900 V St., Sacramento	$NW\frac{1}{4}$ $NE\frac{1}{4}$ 27, 34	16N	6E	M.D.	Idle.
	Golden Key	W.J. Mellon, Challenge	$SW\frac{1}{4}$ 33	19N	6E	M.D.	A 2-ft. wide quartz vein; 60-ft. open cut; 30- and 50-ft. shafts. Idle. (Waring, C.A. 16, p. 448)
	Golden Needle	Edwin J. Lague, Brownsville	34	19N	6E	M.D.	An old hydraulic mine. Idle. (Waring, C.A. 16, p. 439)
	Good Hope		34	15N	6E	M.D.	An 18-in. wide quartz vein; 150-ft. shaft. Idle. (Crawford, J.J. 94, p. 320; 96, p. 500; Waring, C.A. 16, p. 449)
10	Good Title (Templar No. 1)	T.J. Williams Estate, c/o Leanor Williams, Dobbins	Lot 37 $NW\frac{1}{4}$ $NW\frac{1}{4}$20	18N	7E	M.D.	A 30-in. wide quartz vein; 700-ft. adit. Idle. (Crawford, J.J. 96, p. 500; Logan, C.A. 30, p. 188; 31, p. 248; Waring, C.A. 16, p. 449)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hammon, W.P., & Evans, R.D.	Yuba Consolidated Gold Fields, 351 California St., San Francisco	28?	16N	5E	M.D.	Yuba No. 1 and No. 2 dredges, commissioned 1903-04; now dismantled. (Waring, C.A. 16, p. 428; Winston, W.B., and Janin, Chas. 10, pp. 165-168)
11	Hansonville	Florence E. Preston	5,8	18N	6E	M.D.	A 3-ft. wide quartz vein carrying 3 percent sulphides along contact of porphyry and serpentine; 220-ft. shaft; 40-ft. incline shaft, 475-ft. drift. Idle. (Logan, C.A. 22, p. 607; Waring, C.A. 16, p. 449)
	Hemstreet and Bell						See Rice Bros., Inc.
	Henry George						Some ore and tailing worked by cyanide process in 1925. Idle. (Logan, C.A. 30, p. 188; 31, p. 248)
	Hibbert & Burris	B. Burris and Mrs. E. Hibbert, Browns Valley (1915)	16	16N	5E	M.D.	A 4-ft. qide quartz vein in diorite; 170-ft. shaft; 360-ft. tunnel. Idle. (Crawford, J. J. 94, p. 320; 96, p. 500; Preston, E.M. 90, p. 798; Waring, C.A. 16, p. 449)
	Higgins (Elk Prospect)	L.W. Higgins	$NE\frac{1}{4}$19	18N	7E	M.D.	A pockety quartz vein 1 to 9 feet wide. Idle. (Crawford, J.J. 96, p. 500; Waring, C.A. 16, p. 449)
	Hillside prospect	R.L. Hill, Jr., 1169 Broadway, Oakland (1915)	23	18N	7E	M.D.	An 18- to 24-in. wide quartz vein carrying pyrite and chalcopyrite; 60-ft. incline shaft. Idle. (Waring, C.A. 16, p. 449)
12	Hinton	J.M. & Jessie Hinton, c/o A.R. Hinton, Downieville	$W\frac{1}{2}$,$NW\frac{1}{4}$, $N\frac{1}{2}$,$SW\frac{1}{4}$ 17	18N	7E	M.D.	A new vertical shaft was sunk 60 ft. in 1950. Idle.

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
13	Horseshoe	Horseshoe Gold Mining Co., c/o Jas. B. Lesh, 224 Pleasant St., Roseville	20	19N	7E	M.D.	An 18-in. wide quartz vein in schist carrying free gold; 90-ft. shaft; 450-ft. drainage tunnel. Idle. (Logan, C.A. 22, p. 607; 30, p. 189; 31, p. 249-250; 35, p. 9; Waring, C.A. 16, pp. 449-450)
	Horse Valley placer	Weeds Point Mining Co., c/o Mrs. Etta Sinton, 3065 Clay St., San Francisco	34,35	19N	8E	M.D.	(Waring, C.A. 16, p. 440)
	Industry Bar placer		14?	16N	6E	M.D.	Ten miles NE of Browns Valley on south side of Yuba River above mouth of Keystone Ravine. Idle. (Waring, C.A. 16, p. 442)
14	Jefferson	Empire Star Mines Co., Box 1027, Grass Valley	SE cor. 16	16N	5E	M.D.	A 12-ft. wide quartz vein in diabase; 800-ft. shaft; 1500 ft. of drifts. Idle. Being filled with mill tailings from Pennsylvania mill. (Crawford, J.J. 94, p. 321; 96, 501; Preston, E.B. 90, p. 798; Waring, C.A. 16, p. 450)
	Joe Brown	Burlington Gold Mining Co., c/o Alice C. O'Neil, 635 Page St., San Francisco	10	19N	6E	M.D.	Idle.
	Joe Losey	Joe Losey (1915)	SE$\frac{1}{4}$ NE$\frac{1}{4}$19	16N	6E	M.D.	Forty-acre patent; benches above Yuba River. (Waring, C.A. 16, p. 442)
	Johnson		28	19N	6E	M.D.	A 3-ft. wide vein; 60-ft. incline shaft. Idle. (Crawford, J.J. 94, p. 321; Preston, E.M. 90, pp. 801-802)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
15	Joubert (Depot Hill)	F.J. Joubert Estate	SW$\frac{1}{4}$ SE$\frac{1}{4}$; SE$\frac{1}{4}$ SW$\frac{1}{4}$ 24	19N	8E	M.D.	Hydraulic mine first worked in 1855; gravel is a remnant of the LaPorte-Scales-Brandy Creek channel. (Crawford, J.J. 94, p. 264; 96, p. 375; Logan, C.A. 20, p. 478; 29, pp., 189-190; 35, p. 4; 42, pp. 24-25.)
			NE$\frac{1}{4}$ NW$\frac{1}{4}$; NW$\frac{1}{4}$ NE$\frac{1}{4}$ 25	19N	8E	M.D.	
	Julius Caesar						See Wheaton
	Kingbird drift						See Bean Boys
	Landers Bar placer	B.A. Schubert, Browns Valley (1915)	14?	16N	6E	M.D.	Seven miles NE of Browns Valley, just above narrow in the Yuba River. Gravel is 30 to 40 ft. deep. Idle. (Waring, C.A. 16, p. 442)
	Last Chance (Dexter)	Chas. Yates et al, Marysville (1915)	16	16N	5E	M.D.	A quartz vein 6 to 24 in. wide along diorite-porphyry contact; free gold and sulphides; 90-ft. shaft. Idle. Crawford, J.J. 96, p. 501; Waring, C.A. 16, p. 450)
	Leal prospect	M. Leal, Browns-ville (1915)	26	19N	6E	M.D.	Patented 120 acres. Quartz vein 200 ft.long; 20-ft. shaft on a pocket. Idle. (Waring, C. A. 16, p. 450)
	Lillian Frances (Scott)	Chester Merriam, Dobbins	30	18N	7E	M.D.	Patented 150 acres. Two quartz veins along contact of serpentine and porphyry. Idle. (Waring, C.A. 16, p. 450)
16	Little Kingbird (Big Ledge)	L.E. Marter, 1631 Race St., Phila-	NE$\frac{1}{4}$1	19N	7E	M.D.	A vein averaging 3 ft. in width; 125-ft. shaft; 350-ft. crosscut; 225-ft. drift;

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
16	Little Kingbird (Big Ledge) (cont)	delphia, Penn.					foreman said 700 tons of ore milled averaged $7.00. On the Big Ledge which is 20 ft. wide, only a little shallow work was done years ago. (Logan, C.A. 22, p. 607; 30, p. 190; 31, p. 250; Trask, P.D., and others 50, pp. 347-348; Waring, C.A. 16, p. 440)
	Lone Cedar placer		4	17N	6E	M.D.	Idle. (Waring, C.A. 16, p. 442)
	Lone Jack		16	16N	5E	M.D.	Idle. (Waring, C.A. 16, p. 442)
	Lone Tree		20	15N	6E	M.D.	An 18-in. wide quartz vein in slate carrying free gold; 100-ft. incline shaft. Idle. (Waring, C.A. 16, p. 451)
	Lost Channel	Arthur C. & Ella W. Butler, Rt. 1, Box 82, Felton	33	20N	8E	M.D.	166 acres patented land. Idle. (Logan, C.A. 35, p. 8)
	Lucan prospect	Jas. P. Casey	4	18N	6E	M.D.	A 200-ft. shaft and four 10-ft. prospect pits. Idle. (Waring, C.A. 16, p. 451)
	Maggie No. 2 & 3						Production for 1950 reported by H.E. Madhen, North San Juan, California.
	Mammoth Gold Dredge	A.E. Thompson	SE$\frac{1}{4}$ NW$\frac{1}{4}$; SW$\frac{1}{4}$ NE$\frac{1}{4}$ 28	16N	6E	M.D.	The Sunmar Dredging Co. of Oroville operated a dragline dredge on this property in 1940. Idle. (Averill, C.V. 46, p. 315)
	Manwaring prospect		33	15N	6E	M.D.	Considerable drifting. (Waring, C.A. 16, p. 451)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Manzanita (Abbie)						See Abbie
	Marc Anthony	Alvina Gunning, c/o Alvina Geraghty, 231 Briar Lane, San Mateo	20,29	16N	6E	M.D.	A 6-ft. wide quartz vein in slate; 195-ft. incline shaft; 30-ft. tunnel; 225 ft. of drifts. Idle. (Crawford, J.J. 96, p. 501; Waring, C.A. 16, p. 452)
	Marysville Dredging Co.		36 1.2	16N 15N	4E 4E	M.D. M.D.	Purchased by the Yuba Consolidated Gold Fields in February 1925. (Logan, C.A. 19, pp. 23, 24, 25, 99; 20, p. 490; 30, p. 193; 31, p. 253; Waring, C.A. 16, pp. 428, 429, 430; Winston, W.B. and Janin, Chas. 10, pp. 170-172)
	Mexican	Burlington Gold Mining Co., c/o Alice C. O'Neil, 635 Page St., San Francisco	$S\frac{1}{2}$10	19N	6E	M.D.	Idle.
	Montclair placer		$W\frac{1}{2}SW\frac{1}{4}$ 21	16N	6E	M.D.	In the bed of the Yuba River. Idle. (Waring, C.A. 16, p. 443)
	Mosquito placer	E.E. Morey and John Nelson, Dobbins (1915)					In the Dobbins district 6 miles SE of Brownsville. (Crawford, J.J. 94, p. 321; 96, p. 501; Waring, C.A. 16, p. 443)
17	Mount de Oro (Beik)	L.E. Crouch et al., 612-614 Spaulding Bldg., Portland, Oregon	$S\frac{1}{2}SW\frac{1}{4}$ 9	19N	7E	M.D.	A quartz vein 2 to 5 ft. wide carrying free gold and sulphides was developed by an adit, drifts, raise and a shaft. Some ore milled in a 5-stamp mill. Idle. (Logan, C.A. 22, p. 607; 30, pp. 190-191; 31, 250-251)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mount Hope						See Beehive
	Napa and Oro	B.D. Dobbyns, Brownsville, P.S. King & W. Collins, Napa (1915)	16	19N	6E	M.D.	An 8-ft. wide quartz vein in porphyry. Idle. (Waring, C.A. 16, p. 452)
	Nevada	W.C. Reed, Nicholas, & Margarite Rothe et al	4,8,9	18N	8E	M.D.	A dragline operation on Willow Creek by W.I. Lanham of Camptonville in 1950. Idle. (Logan, C.A. 24, p. 84; Waring, C.A. 16, p. 440)
	Neversweat placer (Barton, Boston Hill)	L.J. Adams et al	E½NE¼ 36	20N	7E	M.D.	Coarse gravel, overlain by andesite; 300- and 900-ft. tunnels. Idle. (Waring, C.A. 16, p. 438)
	New Blue Point	Interstate Holding Co., Marysville	NE¼NW¼ 34	16N	6E	M.D.	Bench gravels. A large slide stopped preparation to operate prior to 1916. Idle. (Waring, C.A. 16, p. 440)
	Nineteen Hundred and One		16	16N	5E	M.D.	Two 3-ft. wide quartz veins in diabase; 45-ft. shaft. Idle. (Waring, C.A. 16, p. 452)
	Northern Light		16	16N	5E	M.D.	A 3-ft. wide quartz vein in slate; 35-ft. shaft. Idle. (Waring, C.A. 16, p. 452)
	North Star (Eagleville)	G.W. Lund, Nora I. Haines, Richard Schuman, Oakland	20,21	20N	8E	M.D.	Narrow quartz stringers in slate and granite; 150-ft. shaft; 650 ft. of drifts. Idle. (Waring, C.A. 16, p. 452)
	Nugget & Coronado Mining and Milling Co.		20	16N	6E	M.D.	A 4-ft. wide quartz vein along contact of slate and granite. Idle. (Waring, C.A. 16, p. 452)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Oak Valley and Willow Creek placer		8?	18N	8E	M.D.	A dragline operation on Willow Creek by J.E. Clark, Camptonville, California in 1950.
	Old Flag (Slag)	Mrs. E. Hibbert, Browns Valley, California (1915)	9	16N	5E	M.D.	Two veins of ribbon quartz 4 to 10 ft. wide; 300-ft. incline shaft; 800-ft. drift. Idle. (Crawford, J.J. 96, p. 502; Waring, C.A. 16, p. 455)
	Old Pittsburgh		17	19N	8E	M.D.	An old drift mine. Idle. (Crawford, J.J. 94, p. 321; 96, p. 502; Waring, C.A. 16, p. 438)
	Old Spanish (Golden Arrow)						See Golden Arrow
	Ora Lewa	J.E. Ebert, Marysville, and W.J. Mellon, Challenge (1915)	7	18N	6E	M.D.	Small pockety quartz stringers along a granite-porphyry contact; 73- and 60-ft. shafts. Idle. (Waring, C.A. 16, p. 452)
	Pacific Gold Dredging Co. (Yukon Gold Dredging)		25	16N	5E	M.D.	Formerly Yukon Gold Dredging Co. Operated a bucketline dredge on the Yuba River; finished dredging March 10, 1923. (Logan, C.A. 30, p. 193; 31, pp. 253-254; Waring, C.A. 16, pp. 431-432)
	Paul Ehmann & Richard Cainne						An old drift mine on the west side of Lone Tree Hill; 150-ft. shaft and drifts. Idle. (Waring, C.A. 16, p. 438)
18	Payne placer	Edna V. Payne, Dobbins	NW¼23	18N	7E	M.D.	Dobbins district; producer in 1950.

GOLD (cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Peerless Mining Co.		28	16N	6E	M.D.	A 6-ft. quartz vein along a diorite-slate contact. Idle. (Waring, C.A. 16, p. 453)
19	Pennsylvania	Empire Star Mines Co. Ltd., Box 1027, Grass Valley, California	E$\frac{1}{2}$SE$\frac{1}{4}$ 16	16N	5E	M.D.	Old workings reached a depth of 1600 ft. No recent production. The mill is used to treat ore from adjoining Dannenborge mine. (Logan, C.A. 35, p. 8; Preston, E.B. 90, p. 798; Waring, C.A. 16, p. 447)
	Pittsburgh						See Deer Creek
20	Poor Boy	C. E. & J.C. Merriam, Dobbins, Calif.	NW$\frac{1}{4}$, SE$\frac{1}{4}$ 7	18N	7E	M.D.	Patented 21 acres. Idle.
	R.C.		26	19N	6E	M.D.	Part of B.A.C. property. A 4-ft. quartz vein along a diorite-slate contact; 137-ft. shaft; 800-ft. tunnel. Idle. (Crawford, J. J. 94; p. 322; 96, p. 502; Waring, C.A. 16, p. 453)
	Race Track placer		9	19N	8E	M.D.	At the mouth of Slate Creek. Partly equipped for a hydraulic operation in 1931. Idle. (Logan, C.A. 35, p. 9)
	Railroad Hill		36	19N	8E	M.D.	Gravel 30 ft. deep, no capping. Idle. (Waring, C.A. 16, p. 441)
	Rattlesnake	George Smithurst, Browns Valley	SW$\frac{1}{4}$ NE$\frac{1}{4}$9	16N	5E	M.D.	An 18-in. wide quartz vein in diorite; 300-ft. incline shaft; 500 ft. of drifts. Idle. (Crawford, J.J. 94, p. 322; 96, p. 502; Waring, C.A. 16, p. 435)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
21	Red Cross	Red Cross Mining Co., Dobbins, California	29	18N	7E	M.D.	Two flat veins of decomposed quartz 8-18 in. wide lie 20 and 40 ft. below the surface; 200-ft. shaft; some stoping; a cyanide plant. Idle since 1942. (Logan, C.A. 30, p. 191; 31; p. 251; 35; pp. 9-10; Waring, C.A. 16, p. 453)
22	Red Ravine	Red Ravine Mining Co., c/o H.A. Geach, 150 Almaden Ave., San Jose	SE$\frac{1}{4}$NW$\frac{1}{4}$ 19	18N	7E	M.D.	An 18-in. wide quartz vein carrying free gold and sulphides along a diorite-porphyry contact; 90-ft. shaft; 175 ft. of drifts; two-stamp mill. Idle. (Waring, C.A. 16, pp. 453-454)
	Rogers		6	18N	6E	M.D.	An 18-in. wide quartz vein carrying free gold and chalcopyrite along a slate-diorite contact; 150-ft. tunnel; 50-ft. drift. Idle. (Waring, C.A. 16, p. 454)
	Santa Rosa		5	18N	6E	M.D.	A 3-ft. quartz vein in slate; 475-ft. tunnel; five-stamp mill. Idle. (Waring, C.A. 16, p. 455)
	Seaborg & Davis	J.E. Ebert, Marysville, and W.J. Mellon, Challenge (1915)	32	19N	6E	M.D.	Patented 160 acres; five quartz veins along diorite-slate contact; 100-ft. incline shaft. Idle. (Waring, C.A. 16, p. 454)
	Slag						See Old Flag
	Smartsville Consolidated						See Deer Creek

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Smithurst	George W. Smithurst, Browns Valley (1915)	8,9	16N	5E	M.D.	A 6- to 36-in. quartz vein in diorite; 70-ft. incline shaft; 200 ft. of drifts. Idle. (Waring, C.A. 16, p. 455)
	Solidarity Group & Pine Flat #3 placers						Camptonville district. Worked by Clyde E. Estey of Camptonville in 1950.
	Spanish	W.J. Mellon, Challenge (1915)	$W\frac{1}{2}$ $SW\frac{1}{4}$33	19N	6E	M.D.	A 7-ft. wide quartz ledge along contact of slate and porphyry; 60-ft. open-cut; 50 ft. shaft. Idle. (Waring, C.A. 16, p. 455)
	Spotted Cow prospect		15	18N	7E	M.D.	A 10-ft. wide quartz ledge in granite, 30-ft. drift. Idle. (Waring, C.A. 16, p. 455)
	Summit Hill	Greenwold. Co., 310 Sansome St., and H. Levi & Co., 111 New Montgomery St., San Francisco	22,23 26	18N	7E	M.D.	A 3- to 6-ft. wide quartz vein along contact of slate and granite; 260-ft. shaft; flooded. Idle. (Waring, C.A. 16, p. 455)
	Sweet Vengence	M.A. Johnson and J.A. McLaughlin	4,5,9	16N	5E	M.D.	A 20-ft. wide quartz vein diorite; 350-ft. incline shaft. Idle. (Crawford, J.J. 94, p. 322; 96, p. 502; Waring C.A. 16, p. 455)
	Templar No. 1						See Good Title
	Templar No. 3	J. Merriam, Dobbins, (1915)	29	18N	7E	M.D.	A 2-ft. wide quartz vein in granite; stoped out 50 ft. in depth. Idle. (Crawford, J.J. 94, p. 322; Waring, C.A. 16, p. 456)
	Timbucktoo	W.J. Meeker, P.R. Edwards, E.M. Meeker, et al.	$SE\frac{1}{4}$ $NW\frac{1}{4}$29	16N	6E	M.D.	Idle.

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Too Handy	Mr. Sweezy, Sacramento, Mr. Austin, Live Oak	$NE\frac{1}{4}$ $SW\frac{1}{4}$; $NW\frac{1}{4}$ $SE\frac{1}{4}$ 22	16N	5E	M.D.	A 12-in. wide quartz vein; 30-ft. shaft. Idle. (Logan, C.A. 30, pp. 181-192; 31, p. 252; Waring, C.A. 16, p. 456)
	Twentieth Century Wonder	Josephine Rose de Marshall, Rackerby (1915)	5	18N	6E	M.D.	A 6- to 36-in. quartz vein in diorite; 100-ft. incline shaft; 200-ft. tunnel. Idle. (Waring, C.A. 16, p. 456)
	Union Placer	B.D. Hefferon	22,23	19N	6E	M.D.	Forty acres patented land. Idle.
23	Weeds Point Placer	George R. & Dorothy Jones, 2700-25th Ave., Oakland	26 $NE\frac{1}{4}$ $NW\frac{1}{4}$35	19N 19N	8E 8E	M.D. M.D.	Camptonville district. Operated by C.R. Lambert, Camptonville, 1950.
	Wheaton (Julius Caesar)		29	16N	6E	M.D.	An old drift mine; 120-ft. incline shaft. (Preston, E.N. 90, pp. 796-797; Waring C.A. 16, pp. 438-439)
	Whitney	J.E. Ebert, Marysville (1915)	3	14N	6E	M.D.	A 6-ft. wide quartz vein in diorite; 50-ft. shaft. Idle. (Waring, C.A. 16, p. 456)
	William Arthur	James H. & Eunice Lague, Rackerby	$E\frac{1}{2}SW\frac{1}{4}$ 5	18N	6E	M.D.	An 18- to 24-in. wide quartz stringer in diorite. (Waring, C.A. 16, p. 456)
	Willow Creek & Oak Valley						See Oak Valley and Willow Creek placer.
	York Mining Co.		25	19N	6E	M.D.	An old hydraulic mine. Idle. (Crawford J.J. 94; p. 322; 96, pp. 502-503; Waring, C.A. 16, p. 441)

GOLD (cont)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
24 to 29	Yuba Consolidated Gold Fields	Yuba Consolidated Gold Fields, 351 California St., San Francisco	1,2 11,12	15N	4E	M.D.	Operated 5 bucketline dredges in Yuba County; own 11,129 acres, of which 6,574 acres are tailing and river bars, 1,065 acres are agricultural, and 3,492 acres are pasture land. (Averill, C.V. 19, pp. 23-24; 20, p. 490; 30, pp. 195-197; 31, pp. 255-258; 35, p. 7; Doolittle, J.F., 98, p. 91; Waring, C.A. 16, pp. 432-437; Winston, W.B. and Janin, Chas. 10, pp. 165-170, 172; herein)
			4,5,6 8	15N	5E	M.D.	
			25,35 36	16N	4E	M.D.	
			13,14, 22,23, 26,28, 29,30, 31,32, 33	16N	5E	M.D.	
			20,29, 30	16N	6E	M.D.	
	Yukon Gold Dredging Co.						See Pacific Gold Dredging Co.

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
30	Bean (Kingbird) prospect	Bean & Nieland Inc., Clipper Mills	36	20N	7E	M.D.	Gold placer with blocks of manganese oxide derived from rhodonite. No shipping grade ore developed. (Jenkins, O.P. 43, p. 208; Trask, Parker D. 50, pp. 347-348; herein)
	Bean	Rufus J. Bean	2	19N	7E	M.D.	(Jenkins, O.P. 43, p. 208; Trask, Parker D. 50, pp. 347-348; herein)
31	Clemens prospect	Fred Clemens	29	19N	7E	M.D.	Oxidized rhodonite exposed; 1 to 3 ft. wide for a length of 15 ft. Idle. (Jenkins, O.P. 43, p. 208; Trask, Parker D. 50, p. 348; herein)

MINERAL PAINT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Dempsey Ranch	John Dempsey (1915)	3	15N	6E	M.D.	A light-red tuff deposit. (Aubrey, L.E. 05, p. 171; 06, p. 342; Waring, C.A. 16, p. 456)
	Mott's Ranch		31?	17N	6E	M.D.	Six miles NE of Browns Valley. A ledge of red oxide and silicate of iron was cut by a ditch. No development. Idle. (Crawford, J.J. 94, p. 407)

SAND AND GRAVEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
32	Hallwood	Rice Bros. Inc., Marysville					On the north bank of Yuba River, 1 mi. east of Marysville. Operated by Rice Bros., Inc. (Herein.)
	Hemstreet & Bell	Rice Bros., Inc., Marysville					Operated by Rice Bros., Inc. (Logan, C.A. 30, p. 199; 31, p. 259)
33	Marysville Rock Products	Rice Bros., Inc., Marysville					Plant is on the north bank of Yuba River near the east city limits of Marysville. Operated intermittently by W.G. Davis of Marysville. (Herein)
	Marysville Sand Co., Inc.						Plant on south side of the Yuba River opposite Marysville. (Logan, C. A. 30, p. 199; 31, p. 259)
34	Pacific Coast Aggregates, Inc.	Pacific Coast Aggregates, Inc., Marysville	19	15N	4E	M.D.	A sand- and gravel-screening plant on the Yuba River in Marysville (Logan, C.A. 30, pp. 199-200; 31, pp. 259-260)
	Pratt Building Materials Co.						Consolidated with Pacific Coast Aggregates. (Logan, C.A. 30, p. 200; 31, p. 260)
35	Rice Bros. Inc.	Rice Bros., Inc., Marysville					Produce screened sand and gravel from Yuba River bars east of Marysville and from dredge tailings. Operate an asphalt road-mix plant and a concrete batching plant in Marysville. (Herein)
36	Yuba River Sand Co.	Yuba River Sand Co., Marysville					Produce sand and gravel from material pumped from Yuba River at Marysville. (Logan, C.A. 30, p. 200; 31, pp. 260-261; Waring, C.A. 16, p. 458; herein)

FABRICAS

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 48 JULY 1952 No. 3

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

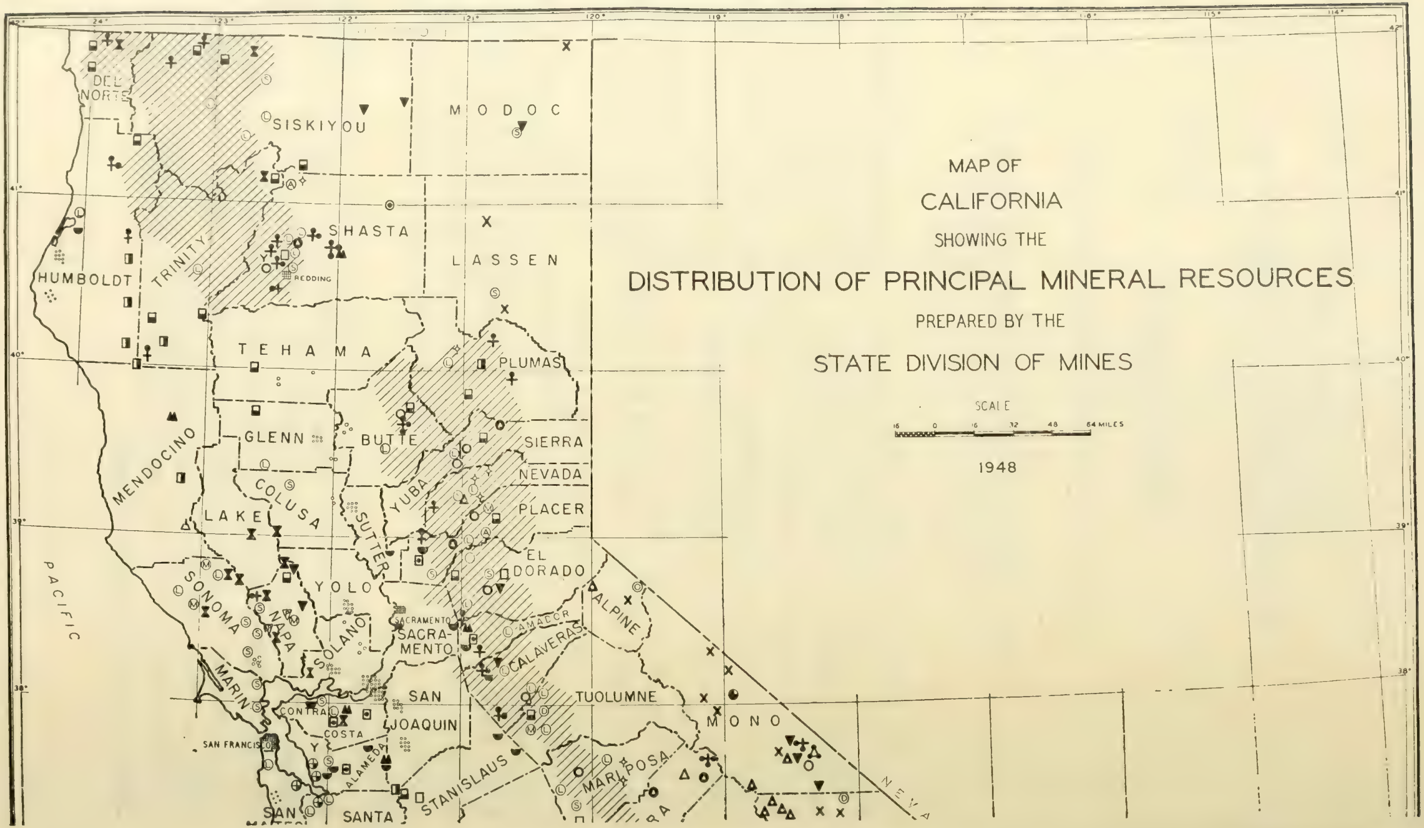
Headquarters
Third Floor, Ferry Building, San Francisco 11

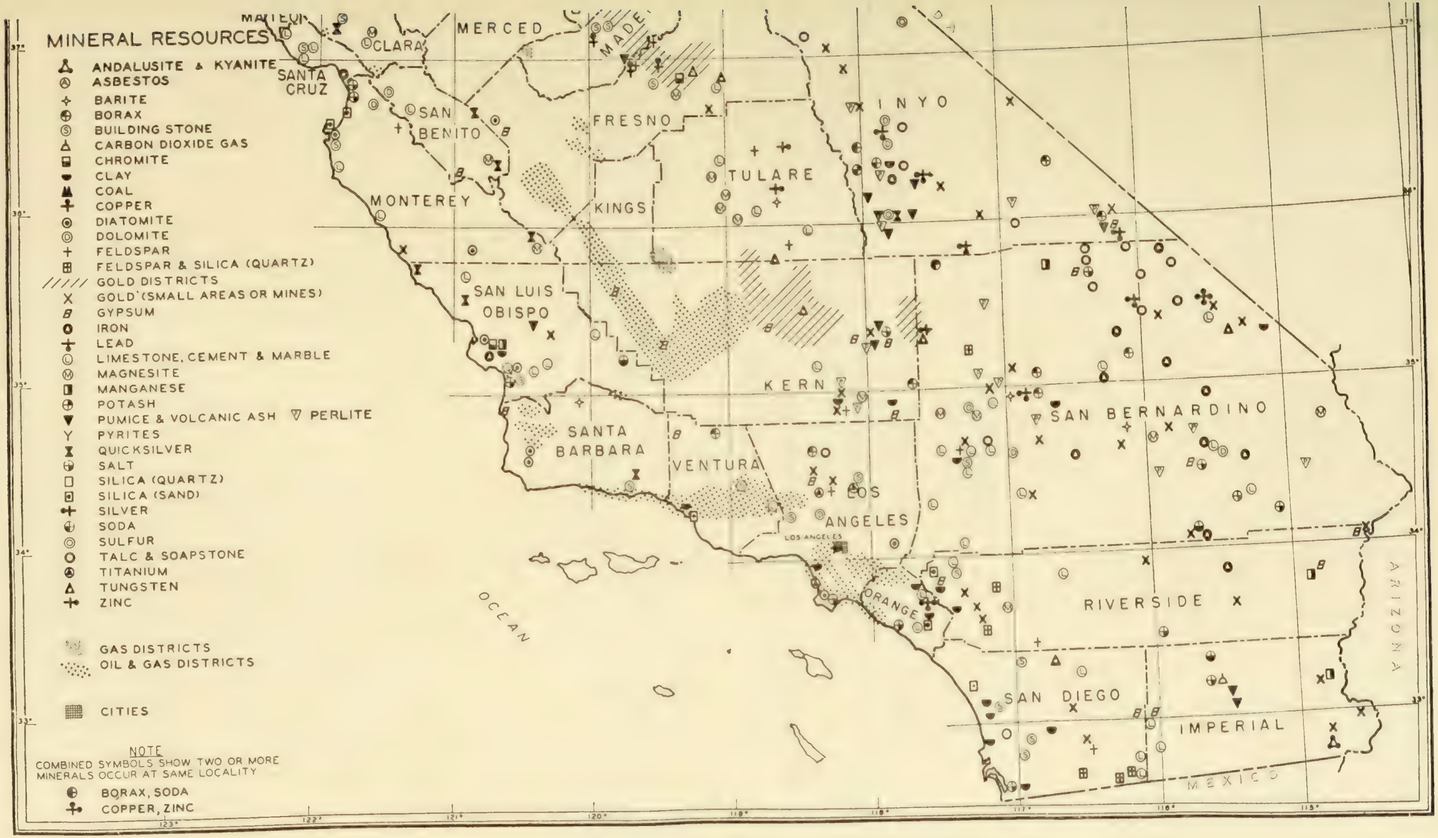
Branch Offices
State Building, 217 West First Street, Los Angeles 12
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
SONOMA
NAPA
YOLO
ALPINE
SACRAMENTO
SACRA-MENTO
AMADOR
SOLANO
CALAVERAS
MARIN
SAN JOAQUIN
TUOLUMNE
CONTRA COSTA
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
PACIFIC
NEVADA


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY
BORAX, SODA
COPPER, ZINC
MERCED
CLARA
SANTA CRUZ
SAN BENITO
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN

CONTENTS

Plates

CALIFORNIA TALC IN THE PAINT INDUSTRY

By Richard S. Lamar *

OUTLINE OF REPORT

Illustrations

ABSTRACT

The growth of the talc industry in California closely parallels the expansion of the building industry and reflects the widespread use of talc in construction materials. In California, the major industrial uses for talc are in the manufacture of paints and low-temperature ceramics such as floor and wall tile. The use of talc in paints is continuing to expand because of improved technology by the talc producers as well as the paint producers. The acicular-platy types of talc manufactured in California have been shown to impart superior durability to paints for exterior exposure. The newly developed ultra-fine talcs pulverized in special types of mills to average particle sizes of less than one micron, are finding application in enamels, lacquers and other paints for interior use.

INTRODUCTION

During the period 1939-47 paint products manufactured in the United States almost tripled in value. In 1939 the total value of paint products produced in the U. S. was $434,960,890. In 1947 this had increased to $1,248,841,000. In spite of inflationary trends, this indicates a general expansion of the industry. The growth of the paint industry in California has closely paralleled the national growth. In 1947 there were 155 estab-

* Technical director, Sierra Talc and Clay Company, Los Angeles. Manuscript submitted for publication September 1951.

lishments in California producing paint products. These companies employed 4,467 workers and produced paint valued at $117,441,000, almost 10 percent of the total annual U. S. production.[1]

In 1939, approximately 35,000 short tons of talc were produced in the state. By 1947, this had increased to over 80,000 short tons. A large amount of this growth can be traced to the increased use of talc in ceramics, especially floor and wall tile. However, much of this expansion is directly attributable to the growth of the California paint industry and the increased use of talc in paint. In 1950 over 100,000 short tons of talc were produced in California. Table 1 illustrates the importance of the paint industry to the talc producers and the general acceptance of talc as an exterior pigment by the paint industry.

Table 1. Use of talc in the U. S., 1949-50.

Use	Percent of total consumption	Use	Percent of total consumption
Ceramics	20	Paper	5
Paint	22	Insecticides	13
Cosmetics	5	All others (including textiles)	23
Rubber	12		

MODERN TRENDS IN PAINT FORMULATION

In recent years extensive research on the part of the paint producers and the makers of paint raw materials, has caused a marked change in the formulation of various types of paints. For example, paints for exterior exposure have undergone radical changes in composition.

Table 2, prepared by W. G. Vannoy,[2] illustrates that the most marked trends in paint formulation have been toward the use of less lead pigments, increased use of titanium pigments, increased use of extender pigments and increased use of thinners and driers. During the period 1940-48, the use of extender pigments increased more than 53 percent.

CHARACTERISTICS OF EXTENDERS

The characteristics of paint containing lead, zinc and titanium pigments can be improved by the incorporation of a certain amount of coarser pigments of relatively negligible tinctorial strength. Such pigments—the so-called extender pigments—include talc, whiting, clay, barytes, diatomaceous silica, slate flour, silica and water-ground mica. Some of the properties which extender pigments impart to paint are: (1) control of consistency and thixotropy, (2) control of gloss and sheen, (3) increased resistance to weathering, mildew, and abrasion, (4) control of setting and increased can stability, (5) promotion of the dispersion of the hiding pigments, such as titanium dioxide, thereby increasing the hiding power or spreading rate of the paint film. Table 3 is an estimate of the quantities of paint extenders used by the paint industry of the west coast.

[1] 1947 census of manufactures, Report No. MC28E, U.S. Dept. Commerce.
[2] Vannoy, W. G., Current house paints, Official Digest, p. 292, May 1949.

*Table 2. Composition of commercial house paint.**

	1940-41**		1947-48**		Percent increase 47–48 : 40–41	Percent decrease 47–48 : 40–41
	Range	Average	Range	Average		
Constituent						
TiO_2	1.00 1.53	1.348	1.24–1.78	1.605	19.07	
ZnO	1.83–3.05	2.560	2.00–3.22	2.770	8.10	
Lead	3.23–5.48	4.190	0.342	1.993		52.43
Extender	2.19–2.33	2.85	2.85–5.08	3.498	53.09	
Oil	4.91–5.11	5.020	3.90–4.93	4.263		17.07
Thinner and drier	0.57–1.02	0.710	0.67–1.86	1.315	85.21	
Percent pigment volume	28.1–29.9	29.375	29.1–36.4	32.875	11.92	
Percent solid volume	89.98–92.03	91.320	72.72–91.77	81.865		10.35

* Figures are averages from nationally distributed house paints according to label analyses. Data from W. G. Vannoy.
** Pounds per gallon of paint.

The action of extenders in paint might be compared with the well-recognized principle of mixing in such materials as concrete, where the voids of a mixture containing coarse, skeletal particles are filled with progressively finer particles, and the whole mass ultimately bonded together by a suitable matrix. In this analogy, the oils and other non-volatile vehicles in the paint are the matrix. The hiding pigments are the finer particle size constituents; the extender pigments, relatively coarse and irregularly shaped, help hold the mass together. Tests have shown that it is commonly desirable for extenders to comprise as much as 35 percent of the solid material in a paint.

USES OF TALC AS AN EXTENDER PIGMENT IN PAINT

Can Stability

The common shapes of talc particles—platy and acicular—make talc particularly effective in reducing the settling tendency of a mixed paint in the can. This is done by the development of a reticular structure which supports the heavier pigments. Moreover, talc, having a lower specific gravity than the hiding pigments shows less tendency to settle out in the finished paint.

Durability

Platy or micaceous particles of extender pigments in the final paint film are smoothed by brushing into positions parallel to the surface to give a scalelike or shingle effect which adds to the impermeability of the film. Acicular particles in the paint film increase the strength of the film by the development of a reticulated or netlike structure.

Talc is thus used by the paint manufacturer as a means of promoting durability, particularly in paints used for exterior exposure. The well known test fence is a familiar sight on or around paint and pigment

plants. The paint manufacturer and pigment producer utilize test panels exposed to the elements for periods ranging from two months to several years to observe the performance of various paints. In this manner some of the causes of paint film failure and values of various pigments and extender pigments have been determined.

*Table 3. Consumption of extender pigments by West Coast paint industry.**

Material	Pounds consumed		
	1936	1941	1946
Talc	20,000,000	25,000,000	29,000,000
Barytes	4,000,000	5,000,000	6,000,000
China clay	8,000,000	10,000,000	12,000,000
Whiting (calcium carbonate)	10,000,000	13,000,000	15,000,000
Silica	4,000,000	5,000,000	6,000,000
Total consumed (West Coast)	46,000,000	58,000,000	68,000,000

* Data from M. W. Reece and H. L. Wampner.

Usually the most desirable method of film failure of paints for exterior exposure is by a slow disintegration of the paint film by "chalking"—gradual wearing away, characterized by the ability to rub off minute particles of pigment with the hands. This is also known as "self-cleaning" characteristic of a paint film. Rain or the use of the garden hose will clean the paint film by washing off the chalked particles and along with them, the accumulated dirt.

White lead and titanium dioxide have a tendency to over-chalk. Talc, owing to the reticulated structure it develops in paints, prevents over-chalking and slows chalking to the desired very gradual. In a good exterior house paint, this chalking should continue for about four years until the surface is clean and smooth and ready for repainting.

Paints containing large amounts of zinc oxide have a tendency to fail by cracking or checking due to extreme hardness. Talc retards this type of film failure by increasing the strength of the film. This is done by the interlocking effect of coarse, irregularly shaped particles.

Consistency and Thixotropy

The consistency of paint is an important characteristic. It must flow readily and smoothly under the action of the brush; after application it must flatten out under the surface tension of its vehicle so as to eliminate brush marks and other irregularities. It must not run on inclined surfaces nor sag off the underside of horizontal ones. This combination of properties can only be secured in paints acting as non-Newtonian liquids. A good paint must have a yield point high enough to prevent sagging or running and must be thixotropic, readily becoming fluid under action of the brush but setting after brushing ceases. The thixotropic rate of setting should be slow enough so that the brush marks will be eliminated before gel forms and the film begins to harden. This non-Newtonian flow and thixotropic action is secured in paint by using pigment concentrations sufficiently high to give gel-like characteristics

to the fluid. Here again the shape of the pigment particles, particularly the extender pigments, is important. Platy or acicular particles give yield points at relatively low concentrations as compared with granular or more uniform particle shapes.

By the addition of talc or other extenders, it is possible to secure sufficient pigment concentration for non-Newtonian flow and thixotropic action without using the more expensive and sometimes difficult to obtain lead, zinc, and titanium pigments entirely. In other words, talc may be used to "extend" the action of these other pigments as well as impart other desirable characteristics obtainable with only the finer particle size pigments.

Dispersion and Hiding Power

The manufacture of a satisfactory paint involves the complete dispersion of the various pigments in the vehicle. This is accomplished by grinding the pigments in oil, a process which does not subdivide the ultimate particles of the pigments to any significant extent but rather breaks up pigment flocculates into individual particles. Usually the pigments are incorporated in the oil in powerful mechanical mixers and the resulting paste is then ground. Formerly the grinding was done in buhrstone mills, but modern technique favors steel roller mills or high-speed stone mills. In this type of mill the paste is forced through two or more close-set, revolving steel rollers, the mixing or dispersing action being principally one of shear. Light-colored paints, when mixed in this manner, particularly if the concentration of extenders or relatively coarse pigments is high, have a tendency to be darkened or discolored by finely divided metal particles abraded from the steel rolls. Talc, having a hardness of 1 on the Mohs scale, reduces this discoloration tendency to a minimum as compared with some of the other extender pigments having greater hardnesses.

Table 4. Indices of refraction of paint oils, hiding pigments, and extenders.

Oils	Average index of refraction	Hiding pigments	Average index of refraction	Extenders	Average index of refraction
Castor	1.4771	Rutile (TiO_2)	2.70	Talc	1.58
Chinawood	1.5180	Anatase (TiO_2)	2.55	Whiting	1.57
Linseed	1.4800	White lead	1.93	Silica	1.55
Menhaden	1.4850	Zinc oxide	1.99–2.02	Gypsum	1.52
Soybean	1.4813	Lithopone	1.84	Diatomite	1.45

The hiding power of paints is controlled by the formulation, degree of dispersion, and use of various types of pigments. The hiding power of pigment varies with the index of refraction and particle size. The extender pigments, which have indices of refraction very close to that of paint oils, show negligible opacity or hiding power in a paint film. The titanium pigments with the highest indices of refraction also show the greatest hiding or covering power in a paint film (see table 4.)

Although the extenders in themselves have negligible hiding power, they increase the hiding power of the pigments such as TiO_2 in the paint film by aiding in the dispersion of these hiding pigments.

Gloss and Sheen

Generally, any extender added to a paint has a marked effect on the gloss of the paint. The effect varies to a great extent with the type of extender. Talcs, because of relatively high oil absorption and irregular particle shape, cause relatively large reductions in gloss when added to paint. High oil absorption reduces gloss by allowing less free oil to come to the surface of the film, spread out and form a smooth, uninterrupted film due to surface tension. Irregularly shaped particles reduce gloss by protruding through the film thereby forming an uneven surface for light reflection. Extenders of more uniform particle shape, such as whiting, show lower oil absorption and less tendency to reduce gloss.

CHEMICAL AND PHYSICAL PROPERTIES OF PAINT TALC

Talc differs from most other paint extenders in that it can be supplied in a great variety of particle shapes. Commercial talc consists of platy or micaceous, needlelike or acicular, and granular or equant-shaped particles. Moreover, any combination of the different shapes can be produced. In addition to this wide range in particle shape, many talc producers are equipped to grind to different finenesses ranging from relatively coarse 200-mesh grinds to ultra-fine grinds with an average size of less than 1 micron. Talc of such extremely small particle size will give a Hegman fineness of 6 or 7 in a paint film without any additional grinding on the part of the paint producer, a property that is desirable for enamels and smooth texture paints. Because of ease of dispersion, talc of this fineness can be mixed in after grinding the other pigments in the vehicle, making an ideal way to produce and control flat or semi-gloss paints for interior use. This extreme flexibility in particle shape and particle size enables the talc producers to make products for almost any application or type of paint. The properties of various types of paints can be changed and enhanced by using the proper extender. In most applications the physical properties of the extender rather than chemical properties have been proved to be most important.

Talc is found in almost every country in the world. Italy, France, India and the United States are the principal producers. In the United States, New York, Nevada, Montana, Georgia, North Carolina and California account for the bulk of the production. California and New York produce by far the greatest amount of talc used for paint manufacture.

Mineralogy

Mineralogically, talc is a hydrous magnesium silicate which in absolutely pure form would contain 63.5 percent SiO_2, 31.7 percent MgO and 4.8 percent H_2O. It is rarely if ever found completely free from impurities and it is usually associated with related silicate minerals as well as calcium magnesium carbonates. Commercial talc may contain almost 100 percent of the mineral talc or may contain very little of the mineral talc depending upon the grade and source. Talc is formed in nature by a hydrothermal alteration of either silicate or magnesium carbonate minerals. The talc deposits of New York State were formed by the alteration of tremolite and other amphibole minerals.

Particle Shape

The material sold as commercial talc commonly contains much unaltered tremolite and indeed may contain more tremolite and related amphibole minerals than the mineral talc. Talc that is an alteration product of tremolite or other acicular types of minerals, shows a tendency to form acicular-shaped particles when pulverized. Talc that is an alteration product of the mineral dolomite commonly pulverizes to equant or platy particles. This type is not considered suitable for most paints but when chemically pure, is used extensively in the manufacture of special types of ceramics. Some granular-shaped talc is used to a limited extent in special paints such as enamel undercoats and sealers.

Chemical Composition

Talc from different localities and different mines varies widely in chemical and mineralogical composition, depending to a great extent upon the type of mineral alteration that has occurred and the quantities of mineral impurities left with the talc after alteration. The analyses in table 5 are of talc from several California localities. All have been used for paint manufacture.

There appears to be no correlation between chemical composition of talc and its properties in paint. Talc itself and most of the mineral impurities that occur with it are nearly if not completely insoluble silicates which are generally chemically inert in the paint film. The effects of false-bodying and soap-formation are negligible. Therefore the properties that talc imparts to paint are due mainly to physical changes rather than a reaction between the extender and vehicle.

Table 5. Chemical analyses of some California paint talcs.

	A[1]	B[1]	C[2]	D[2]	E[3]
H_2O-	0.10	0.42	0.19	0.06	0.24
H_2O+	4.40	3.63	5.01	5.17	3.34
CO_2	4.36	4.75	0.46	0.39	2.89
SiO_2	55.90	54.80	60.55	59.65	54.65
Al_2O_3	1.24	1.15	1.38	2.74	1.42
Fe_2O_3	0.31	0.18	0.51	0.55	0.28
TiO_2	0.08	0.12	0.05	0.01	none
MnO	0.003	0.006	none	none	0.014
CaO	4.77	6.24	1.19	1.27	11.70
MgO	28.77	26.82	30.70	30.09	25.60
Na_2O	0.44	1.71	0.31	0.21	0.58
K_2O	0.28	0.72	0.05	0.03	0.20
Totals	100.65	100.55	100.40	100.17	100.90

[1] Material composed mostly of the mineral talc in acicular to platy particles. Also contains several percent calcite and dolomite and probably a trace of tremolite.
[2] Talc of steatite purity composed of equant to platy grains. Reground to ultra-fine particle size.
[3] Material rich in tremolite in acicular particles. Also contains several percent calcite and probably a subordinate proportion of the mineral talc.

Particle Size Distribution

Talc from different localities varies not only according to chemical composition and particle shape, but also in particle size distribution because of innate differences in hardness and grindability and because of different methods used for pulverization and classification. Talc

samples from two different localities may be ground to exactly the same screen or sieve size and yet show greatly different results in the subsieve range of sizes. This can be illustrated by the particle size distribution of the material showing the complete range of the particle size. The particle size distribution for the same group of talcs shown previously is shown in table 6 and figure 1.

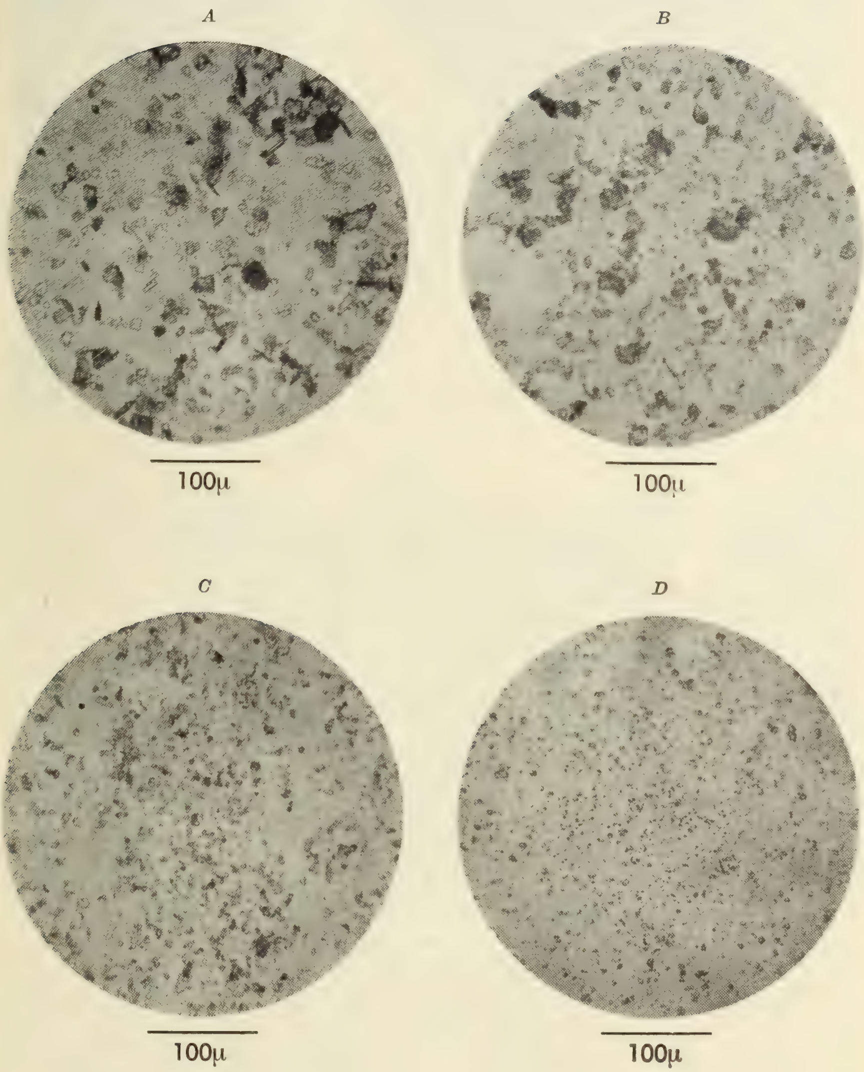
The differences in particle shape and particle size have a direct bearing upon such factors as consistency, oil absorption or binder demand, flatting, ease of dispersion in the paint vehicle, settling, can stability, and resistance to weathering as well as the other factors considered by the paint chemist.

Talcs A and B, shown in the tables, are a type widely used in the formulation of white exterior house paints. Such talc is usually pulverized so that 98 to 99.6 percent passes a 325 mesh screen, and contains both platy- and acicular-shaped particles which have been shown to increase exterior durability. The principal impurities, calcium and magnesium carbonates, are chemically inert in this application and do not detract from the value of the extender. Talcs A and B—or similar talcs—are also used in large quantity by the armed forces in the formulation of low-gloss camouflage paints. It was found that the needleshaped particles protrude through the paint film, providing an irregular surface for light reflection, thereby increasing diffusion and reducing gloss. Diatomaceous earth, because of its extremely irregular shape, is also used in this manner. Talc and diatomaceous earth are also used in the production of flat or low-gloss house paints. Whiting or crystalline calcium carbonate is usually preferred for high-gloss paints. Because of the equant particle shape and low oil absorption as compared with talc, limestone shows less flatting effect or gloss reduction in paint than does talc.

*Table 6. Particle size distribution of California paint talcs.**

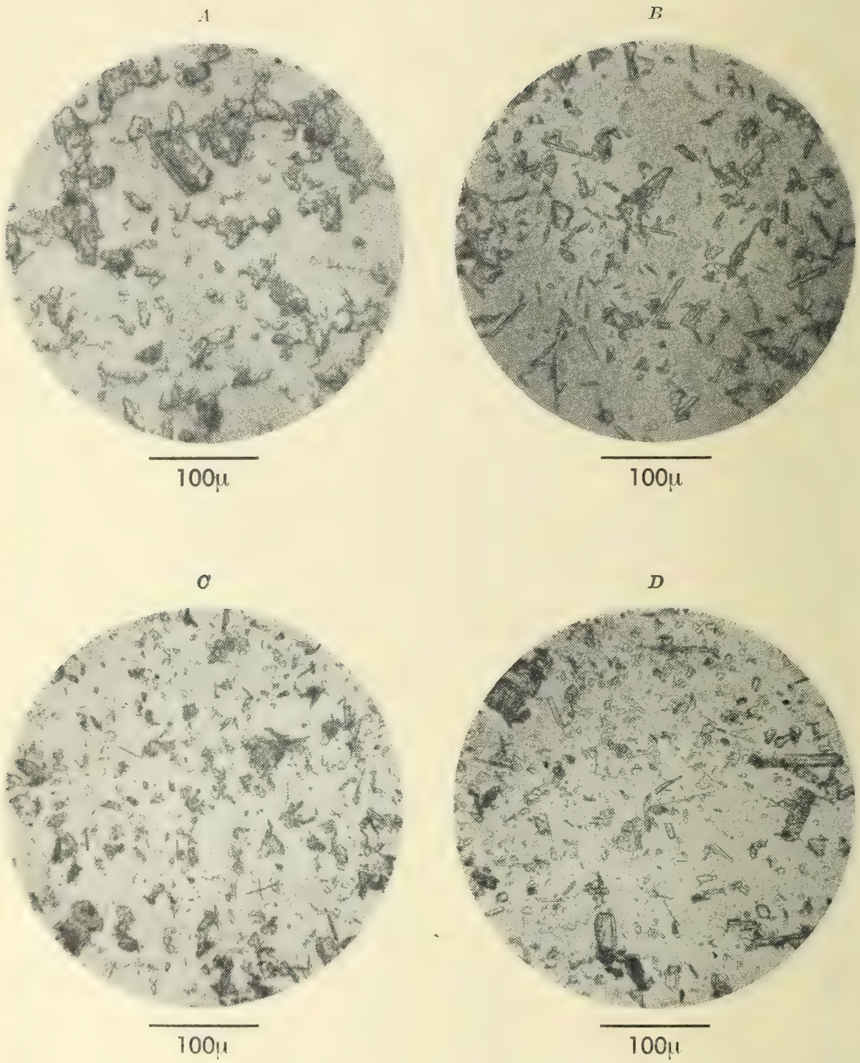
Equivalent spherical diameter in microns	Percent finer than indicated sizes				
	A	B	C	D	E
50	100.0	100.0	100.0	100.0	100.0
40	100.0	100.0	97.4	100.0	100.0
30	100.0	100.0	90.0	100.0	92.4
20	91.0	90.8	74.9	100.0	70.9
15	76.0	80.0	63.0	100.0	53.2
10	49.0	62.2	49.0	98.3	36.0
7.5	33.0	49.5	38.4	93.1	26.8
5	19.0	33.8	24.0	77.2	17.8
4	13.5	26.9	17.5	64.9	14.5
3	9.0	19.8	11.9	50.8	11.0
2	5.0	12.2	7.0	34.5	7.5
1	2.6	5.2	2.8	15.0	4.0
0.75	2.0	3.5	1.3	9.4	2.9
0.50	1.0	2.0	0.8	3.2	0.9
0.40	0.6	1.0	0.5	0.9	0.0
0.30	0.0	0.0	0.0	0.0	0.0

* Analyzed by Andreasen pipette method. Talc samples are those described in table 5.



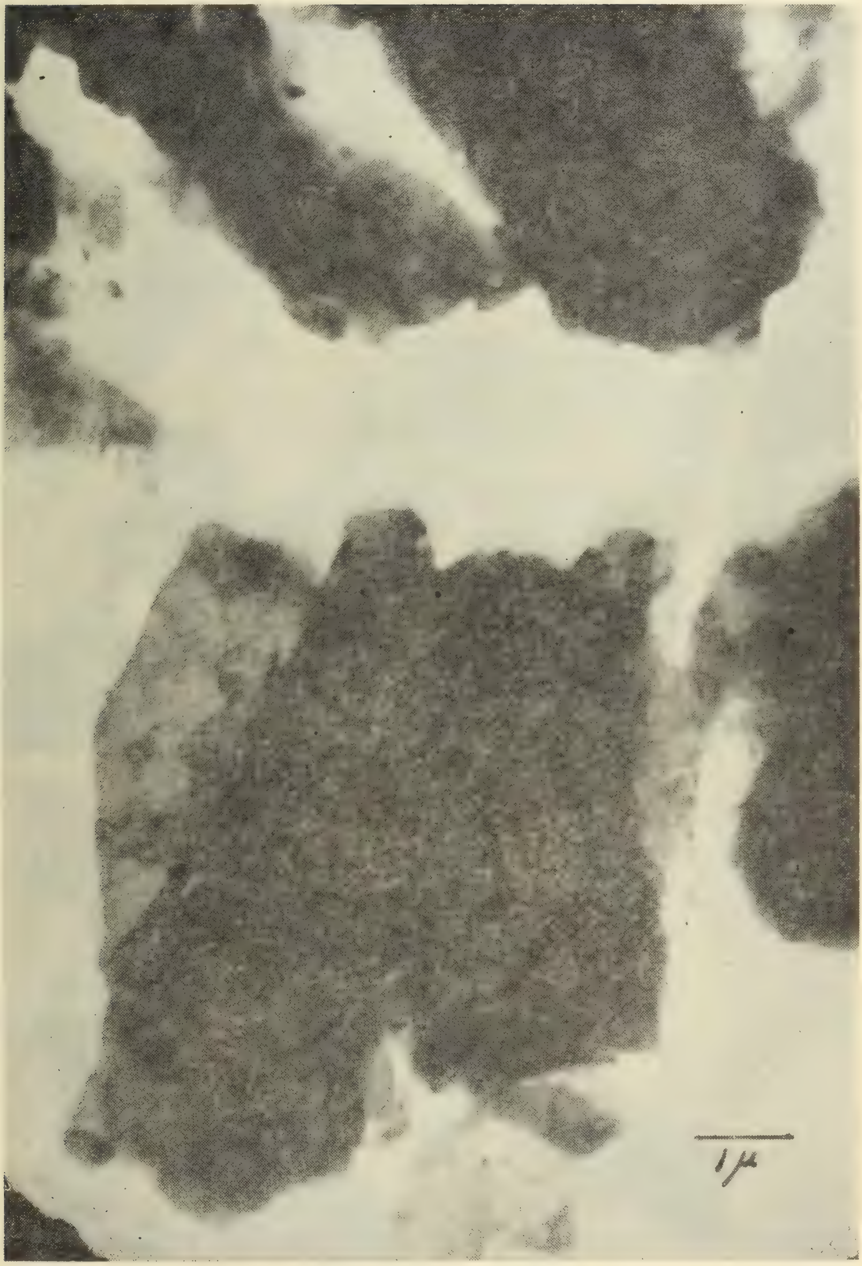
PHOTOMICROGRAPHS OF STEATITE TALC

A. Talc ground so that 99.7 percent passed a 200-mesh sieve. Grinding was done by Raymond ring-roller type mill. Most grains are equant, but elongate grains are abundant. *B.* Same talc reground in same mill so that 99.9 percent passed a 325 mesh sieve. Fewer elongate grains may be seen. *C.* Talc reground in jet type mill to minus 15 microns. *D.* Talc reground in jet type mill to minus 5 microns.

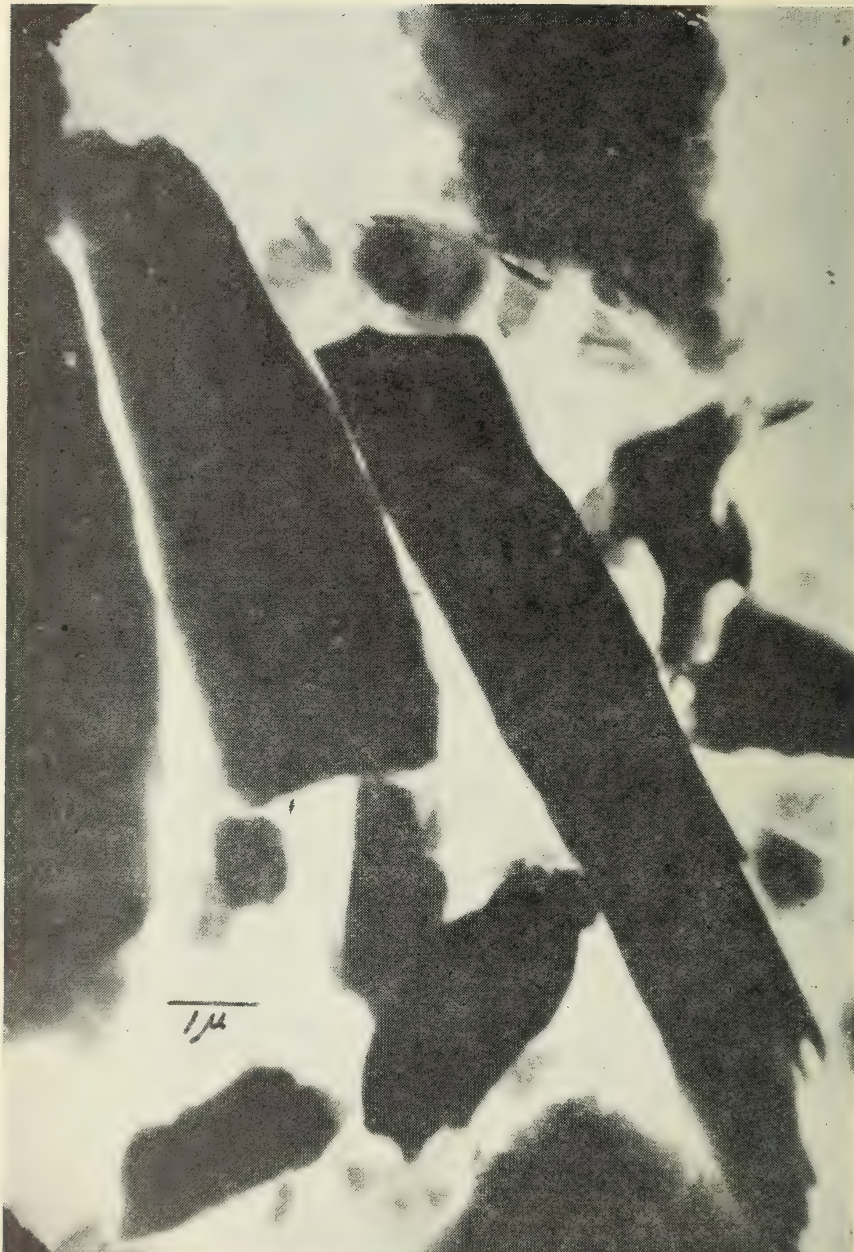


PHOTOMICROGRAPHS OF TALC

A. Platy talc, ground in Raymond mill so that 99 percent passed a 200-mesh sieve. *B*. Acicular talc, ground in same mill so that 99.3 percent passed a 325-mesh sieve. *C*. Platy to acicular talc, ground in Raymond mill so that 99.6 percent passed a 325-mesh sieve. *D*. Highly tremolitic talc, ground in Raymond mill so that 99.6 percent passed a 325-mesh sieve.



PLATY TALC PARTICLE
Showing lamellar structure. Photo is electron micrograph.



Talc containing unaltered tremolite as acicular particle. Photo is electron micrograph.

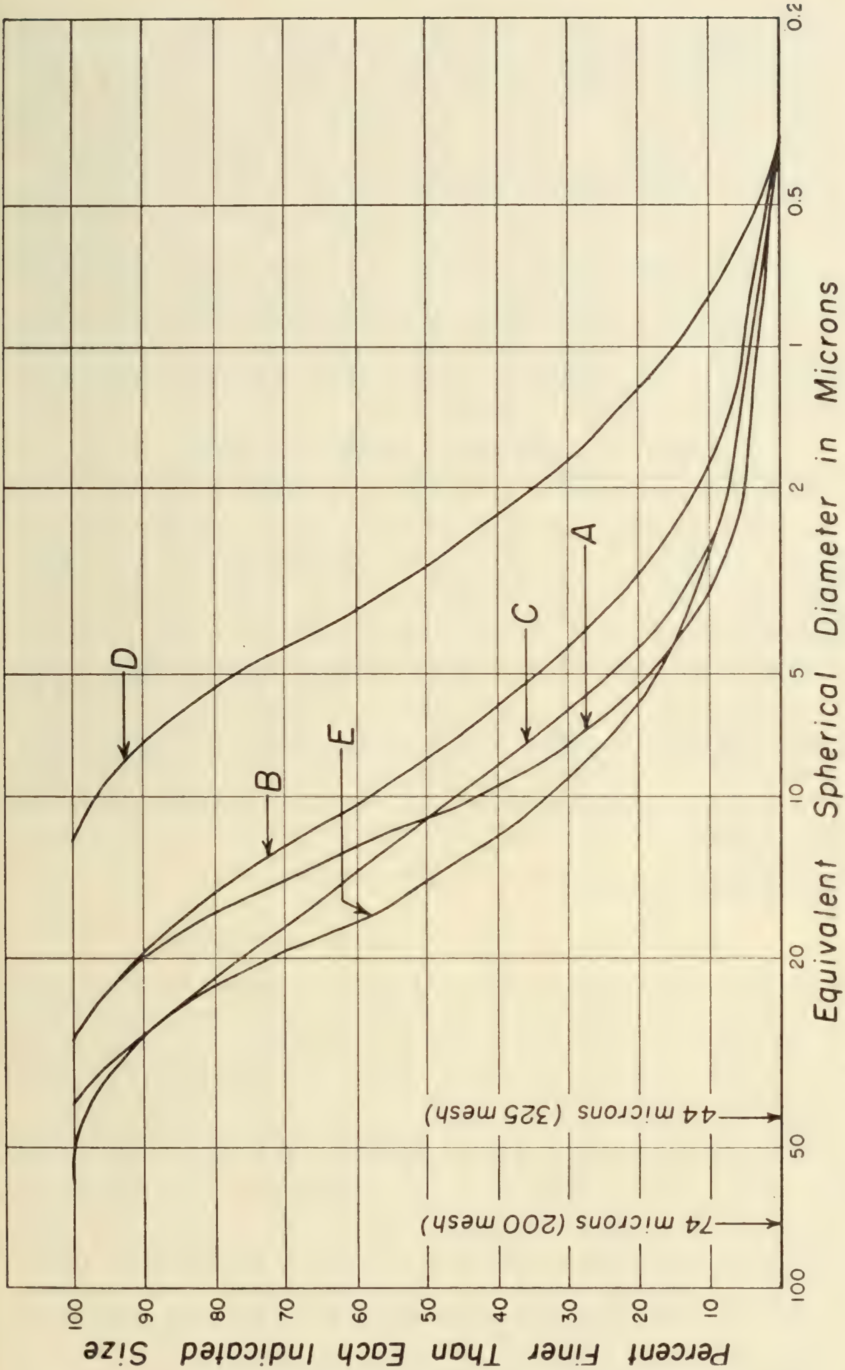


FIGURE 1. Particle size distribution curves of samples of paint talc (see table 4). Analyses by Andreasen pipette method.

Samples C and D, shown in tables 5 and 6, are steatite grade talc. They are relatively pure talc. Their particle shape is more uniform than some other types although some grades of steatite are extremely platy in particle shape; such grades show large increases in viscosity when added to paint and act much like water-ground mica. The materials are particularly amenable to ultra-fine grinding in jet-type mills. Sample D is this grade of talc. The average particle size, as determined by air permeability, is about one-fourth that of the other grades of paint talc, which show great flatting effects because of extremely high oil absorption. However, they impart a smooth surface to the dried paint film because of small particle size. Sample E, a tremolitic talc, is of a type less friable than the other talcs; the tremolitic types usually pulverize with fewer extremely fine particles than do the other types. Such talcs show low oil absorptions and can be added to paints in fairly high percentages without materially increasing the consistency.

Table 7. Physical properties of California paint talcs.[1]

	A	B	C	D	E
Oil absorption, ml/100g[2]	46.5	44.0	46.6	73.0	36.9
Oil absorption, lbs./100 lbs.[3]	37.6	34.0	36.4	58.4	30.0
Consistency,[4] K. U.					
30% suspension	57	56	57	72	54
40% suspension	72	69	74	128	60
50% suspension	116	102	116	>143	77
Specific gravity at 25° c.	2.78	2.79	2.75	2.76	2.84
Surface mean diameter, microns	3.05	2.48	2.93	0.76	3.94
Specific surface,[5] cm²/g.	7,080	8,150	7,440	28,600	5,360
Screen analysis (percent thru 325 mesh)	99.2	99.6	99.6	100.0	99.7
Apparent density, lbs./ft.[3] (Scott volumeter)	23.80	20.0	20.13	9.50	27.47

[1] Talc samples are those described in table 5.
[2] Gardner Coleman method.
[3] Rub-out method.
[4] Determined in linseed oil suspension using Stormer, Krebs modification viscosimeter.
[5] Determined by air permeability method.

PRODUCTION OF PAINT TALC IN CALIFORNIA

Most commercial paint talc produced in California is a blend of crude material from two or more mines. By blending, normal variations in talc from the mines can be controlled and a more uniform finished product made. The usual steps in the process are (1) crushing to half an inch, (2) blending of crude material, (3) dry grinding in Raymond, ring-roller or similar type mills, (4) air classification by means of whizzer separators, cyclones, and baghouse and (5) packaging in 50 pound net, multi-walled, paper bags. Ordinarily no bulk shipments of the ground or pulverized material are made. For the production of ultra-fine grinds, special types of jet mills are employed. These mills employ either compressed air or super-heated steam. Grinding is done by attrition or particle bombarding against particle in a high speed current of either heated air or steam in a circular chamber. These mills are capable of grinding talc to provide a product containing particles of 5 microns or less although the usual commercial product made by this method is usually 15 microns

or less in diameter. Drying, if necessary, is usually done in the mill during the grinding operation. For this purpose, most of the mills are equipped with forced draft, gas- or oil-fired heaters. Drying is usually unnecessary; the incoming crude talc rarely contains more than 0.50 percent free moisture.

The quality of the finished talc is controlled during the blending and grinding operations by various chemical and physical tests. These control tests include all of those shown previously for the various grades or types of talc.

The talc-producing centers of California are located in the desert areas of San Bernardino and Inyo counties. Three mines in these localities have been in continuous operation since 1917 and have produced more than 200,000 tons of crude talc each. Numerous others have been put into operation more recently. All of the mines consist of underground workings made up of a series of tunnels, shafts, drifts, and stopes. The mines are dry and require no draining or pumping. The obvious mineral impurities are sorted out at the mines and discarded. The selected talc is shipped by truck to the most convenient railroad siding. Some of the grinding mills are at the sidings, but most are in the Los Angeles area. Crude talc is also shipped to the San Francisco Bay area for grinding.

Marketing of the finished talc is usually done through jobbers handling complete lines of paint raw materials. Prices of ground and bagged talc range from approximately $20.00 per ton (f.o.b. the grinding plant) for the poorer grades to as much as $80.00 per ton for the ultra-fine grinds of high quality paint talcs.

Because of intelligent, well planned research, the use of talc in paint manufacture is continuing to grow. The California talc producers have taken an active part in this development program and their products are used not only in California, but over the entire United States and in almost every country in the world where high quality paints are made.

4—56800

GEOLOGY OF THE STARBRIGHT TUNGSTEN MINE SAN BERNARDINO COUNTY, CALIFORNIA

By George C. Hazenbush *

OUTLINE OF REPORT

Illustrations

ABSTRACT

The Starbright tungsten mine is in San Bernardino County, California, about 21 miles northeast of Barstow and 2½ miles northeast of Lane Mountain summit.

The region is underlain by a complex of plutonic igneous rocks ranging from quartz diorite to gabbro in composition. Within the complex are masses of metamorphosed sediments possibly Paleozoic in age. One of the smaller of these masses comprises the Starbright deposit.

The Starbright ore body is a tactite body, irregularly ovoid in outcrop pattern, that trends nearly east-west. It dips to the south at about 45 degrees, the footwall less steeply than the hanging wall. The tactite, composed mostly of garnet, is thoroughly crushed. Scheelite, the tungsten-bearing mineral, is disseminated through the tactite.

The deposit is mined by open pit methods. By July 1951 the deposit had yielded over 10,000 tons of ore averaging 1½ to 2 percent WO_3.

Starbright Number 10 claim, a mile northeast of the original workings, is located on a tactite ore body that strikes northeastward and dips 70 degrees northwest. The body has been exposed in an open cut for a length of 30 feet and a width of 20 feet.

INTRODUCTION

The Starbright mine, since its opening in 1950, has attracted widespread interest as the first commercial source of tungsten in the Lane Mountain-Goldstone region of San Bernardino County, California. By mid-1951, the mine had yielded over 10,000 tons of ore averaging 1½ to 2 percent WO_3.

The deposit, discovered in April 1950 by Mr. A. C. Lambert of Barstow, is now owned by Mr. Lambert and Mr. Clair W. Dunton of Mineral Materials Company of Alhambra, California. The original Starbright group, 7 claims in all, is in secs. 19 and 20, T. 12 N., R. 1 E., and lies low on the east flank of a group of hills that extends northward from Lane Mountain. The claims are about 2½ miles northeast of Lane Mountain summit. In June 1951 the company had acquired several other tungsten claims in the area and had begun shipment from one,

* Junior Mining Geologist, California Division of Mines. Manuscript submitted for publication September 1951.

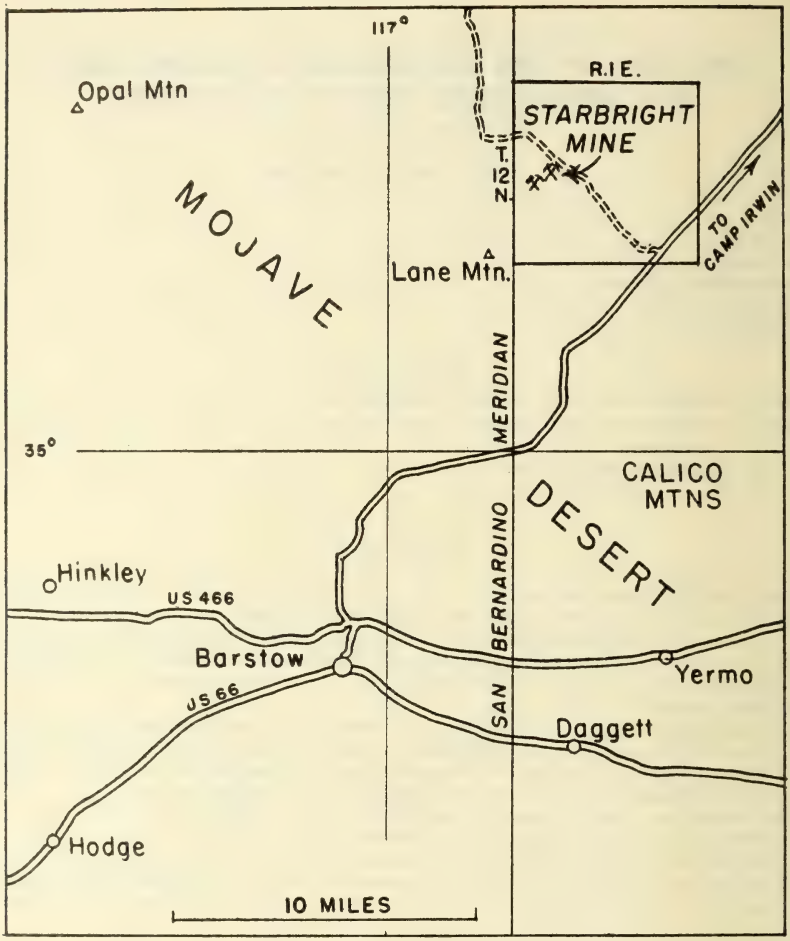


FIGURE 1. Index map of the Barstow area of San Bernardino County showing location of Starbright tungsten mine.

the Starbright Number 10, about one mile northeast of the original group. The property is most easily reached by traveling about 21 miles north from Barstow on the paved Barstow to Camp Irwin road, and thence 5 miles west on a well-graded dirt road to the mine.

This study involved the preparation of a geologic sketch map of the Starbright deposit, and a reconnaissance of the immediate terrane. It is hoped that this work, in addition to providing factual data on the deposit itself, will stimulate the prospecting for other similar deposits in the region.

The writer acknowledges the kind cooperation of Mr. Dunton and Mr. Lambert and the suggestions of Lauren A. Wright of the California Division of Mines who criticized the manuscript. Thane McCulloh of the U. S. Geological Survey provided information on the regional geology.

The general geologic features of the region that includes Lane Mountain and the Starbright mine, have been studied by Thane McCulloh, of the U. S. Geological Survey. As shown by McCulloh on his unpublished map, this region is underlain principally by a complex of intrusive rocks ranging in composition from quartz diorite to gabbro. Within this complex are elongate masses of metasedimentary rock, believed by McCulloh to be roof pendants. These masses, ranging in long dimension from a few feet to more than a mile, trend northward and dip steeply to moderately both westward and eastward. The metasediments, which are mainly quartzite, micaceous schist, and carbonate rocks, are tentatively given by McCulloh [1] as Paleozoic in age. The intrusive rocks are thought to be Mesozoic.

The Starbright deposit is a small tactite body comprising most of one of the roof pendants, and is probably a replacement of an impure limestone. The intrusive complex in the Starbright area is composed mostly, if not entirely, of quartz diorite.

THE STARBRIGHT DEPOSIT

The Starbright tactite body has an irregularly ovoid outcrop pattern about 100 feet long and 50 feet wide. The body strikes westward and has an apparent over-all southerly dip of about 45 degrees. Its foot wall, although irregular, seems to dip less steeply than the hanging wall, suggesting that the body pinches with depth.

The tactite comprises most of the pendant. Scheelite, the tungsten-bearing mineral, is disseminated through the tactite. Between the tactite and quartz diorite is a siliceous border zone that contains subordinate proportions of garnet and diopside and traces of scheelite and ranges in thickness from a few inches to as much as 20 feet. The tactite-siliceous rock contact is sharp but irregular. All three of these rocks—quartz diorite, tactite, and siliceous rock—are thoroughly and intimately fractured. A northeast-dipping amygdaloidal basalt dike is intrusive into the diorite near the southwestern border of the deposit.

The tactite is composed of approximately one-half garnet, one-fifth quartz, one-fourth epidote, and from a trace to 3 percent scheelite. Although mostly a medium-grained rock, it locally contains aggregates of garnet crystals with individuals as much as 3 centimeters in diameter. The textural variations of the tactite appear to be erratic and unrelated to the outline of the body. The rock is buff to brown. Its friability, an effect of thorough crushing, is a feature that has assisted the rock's removal by open-cut methods.

The scheelite occurs as disseminated, anhedral to nearly euhedral grains generally less than 1 millimeter in diameter. Scheelite also occurs in microscopic veinlets interstitial to garnet grains. These veinlets probably are composed of mechanically crushed material. Although the scheelite appears to be rather evenly disseminated through the tactite, locally some of the tactite is nearly barren, containing only minute stringers of scheelite.

A spectrographic analysis made in the State Division of Mines laboratory shows that molybdenum is a minor constituent of the scheelite and that traces of silicon, magnesium, and titanium exist in the ore.

[1] Oral communication, July 1951.

FIGURE 2. General view of Starbright mine.

The siliceous rock bordering the tactite consists of about one-half quartz, one-fourth garnet, one-eighth diopside, and one-eighth calcite and sphene. In hand specimen the rock is dense, hard, and brownish-green to olive-green. Microscopic examination shows a rock of granular texture containing quartz, mostly in irregular grains from 1 millimeter to 3 millimeters in diameter, and garnet in smaller, rounded grains. The mineral tentatively identified as diopside is highly altered. Scheelite is sparsely distributed as grains near the tactite contact.

The quartz diorite is a massive, dark-gray, medium-grained rock, containing about 40 percent feldspar (predominantly andesine with a very small proportion of orthoclase), 10 percent quartz, 40 percent hornblende, and 10 percent biotite. Minor accessories include apatite, zircon, magnetite, garnet, and sphene.

The basalt dike, six feet in maximum width, strikes northwestward and dips steeply to the northeast. It has filled a fracture or fault plane in the quartz diorite. Although the dike is close to the southwest border of the tactite body, it was not observed in contact with tactite. The basalt is greenish-gray on fresh surfaces, and contains abundant round to ellipsoidal amygdules consisting of quartz, calcite, zeolites and milky opal.

Although, as noted above, the rocks of the mine area have been severely crushed, the tactite body is essentially intact. In general, the westerly strike and moderate southerly dip of the body is the attitude of a roof pendant whose contacts with the surrounding quartz diorite are intrusive.

The mine area is traversed by numerous shear planes and faults of minor displacement, some of which strike northeastward and dip steeply to the southeast. The others strike north-northwestward and dip steeply

to the northeast. Because the tactite is a relatively weak rock, individual planes of rupture are less pronounced in it than in the surrounding siliceous rock and quartz diorite.

The ore body on the original Starbright claims is mined by benching. Width of the benches varies from 3 to 6 feet, to conform to the irregularity of the footwall. Vertical holes are drilled on about 5-foot centers to depths of 4 to 10 feet, depending upon the depth to the footwall. During the drilling, cuttings are frequently examined with a fluorescent lamp to determine when the drill passes from ore into waste rock, at which point the hole is stopped.

After blasting, the broken ore is loaded into trucks with a skip-loader, again using an ultra-violet lamp to distinguish ore from waste rock.

In July of 1951, the open pit was about 80 feet long, 60 feet across at the top and nearly 50 feet deep in its deepest part, with an irregular V-shaped cross section. All of this excavation did not represent ore removed, however, as part of the hanging wall was removed to prevent ore dilution. All mining is done at night with the aid of an ultra-violet lamp.

The ore body will be mined by open pit methods as long as practicable. In July 1951, however, the company was planning to drive an inclined shaft down the dip of the tactite at some time.

THE STARBRIGHT NUMBER 10 CLAIM

The Starbright Number 10 claim was located about 1 mile northeast of the original workings in sec. 17, T. 12 N., R. 1 E., on February 29, 1951. Shipping from this new operation started in May, 1951.

FIGURE 3. Starbright open pit. Quartz diorite forms wall at left, siliceous wall rock to right. Ore in left foreground.

Like the original workings, the newer operation is on a garnet-rich tactite body in quartz diorite. Also like the other deposit, it has a discontinuous border zone of hard greenish-colored siliceous rock. The tactite itself appears to be somewhat less crushed than that of the original claims, and the scheelite seems more erratically distributed.

The tactite ore body strikes in a northeasterly direction and dips about 70° NW. Its width as exposed in the open cut is not more than 20 feet. The siliceous walls are from 2 to 20 feet in thickness. A length of tactite of about 30 feet has been exposed by the open cut. Alluvium and lag gravels cover much of the nearby area, but quartz diorite exposures appear to limit the length of the deposit to less than 50 feet.

Before its discovery the Number 10 claim deposit was covered by alluvial material from 2 to 10 feet thick. Discovery was made by trenching with a bulldozer. Other similar small tactite bodies may be uncovered in this way.

ORIGIN OF THE DEPOSITS

The mineral assemblages of the Starbright tactite bodies are characteristic of most tungsten-bearing contact-metamorphic deposits. Such deposits typically occur as replacements of carbonate sedimentary rocks at or near contacts with granitic intrusives. This origin is assumed for the Starbright deposit. However, with the exception of 1 foot of marble encountered in a diamond drill hole, no carbonate material was noted in the Starbright tactite. The replacement, therefore, appears to have been nearly complete.

MILLING OF THE ORE

The ore is trucked to El Diablo mill in Bishop, California for concentration. The mill consists of a jaw crusher, a vibrating screen, a ball mill, four concentrating tables, a cone drier and magnetic separators for removing the iron minerals. Capacity of the mill is 40 tons of ore per 16-hour shift.

Rejects from the magnetic separators contain as much as 0.75 percent WO_3, and are sold to the U. S. Vanadium Company at Pine Creek, near Bishop.

MINES AND MINERAL RESOURCES OF MERCED COUNTY

By Fenelon F. Davis * and Denton W. Carlson **

OUTLINE OF REPORT

Illustrations

ABSTRACT

About 60 percent of Merced County's area lies in the alluvial plain of the San Joaquin Valley. Low rolling foothills of the Sierra Nevada arise from this plain in the eastern part of the county. The western boundary of the county follows the crest of the Diablo Range, part of the Central Coast Ranges of California.

The Mariposa slate of Jurassic age is the oldest of the rocks exposed on the east side of the county. The slates dip nearly vertically and are unconformably overlain by Tertiary sediments and fragmental volcanic rocks which dip slightly westward under the valley alluvium. The Franciscan formation of Jurassic age is the oldest formation exposed in the Coast Ranges side of the county. The Franciscan consists of eastward

* Associate Mining Geologist, California Division of Mines.
** Junior Mining Geologist, California Division of Mines. Manuscript submitted for publication December 1951.

dipping sandstone, shale, and chert, and associated basic intrusive rocks. The intrusives, now largely altered to serpentine, metamorphosed some of the earlier sediments. Eastward dipping Upper Cretaceous sediments unconformably overlie the Franciscan rocks. The Cretaceous rocks are conformably overlain by Tertiary sediments which dip steeply eastward under the valley alluvium. Tertiary volcanic rocks, including andesite, basalt, rhyolite, and fragmental material, are exposed over an extensive area in the Coast Ranges where they overlie the Franciscan formation.

The value of the total recorded mineral production for the county, 1880-1949, is $32,044,600. Merced County ranked thirty-fourth among the 58 counties of the state in 1949. The value of mineral production for that year totaled $834,482, and included production of the following commodities: gold, silver, crude platinum metals, gypsite, and sand and gravel. Peak production was attained in 1938 when the county ranked fourteenth in the state. Other mineral commodities which have been produced in former years include: antimony ore, cement, clay and clay products, copper, and quicksilver.

Substantial quantities of gold have been recovered annually for many years by connected bucket dredges operating in the flood plain of the Merced River between Merced Falls and Snelling. Dredging began in 1907 and was intensively developed between 1929 and 1942. One dredge operated during 1951. Silver and platinum are produced as by-products of gold dredging.

An extensive deposit of Tertiary marine diatomite, exposed in the foothills southwest of Los Banos, is capped by an efflorescent deposit of gypsite. The gypsite is mined and used locally as an agricultural mineral to increase permeability of the soil.

Sand and gravel has been an important part of the Merced County mineral production since 1910. The principal production is obtained from the banks and channel of the Merced River between Merced Falls and Livingston. The main rock types found in this area are: quartz, quartzite, gneiss, granite and related rocks. Los Banos Creek is the locus of numerous sand and gravel plants on the west side of the valley. Here the rock content of the gravels consists primarily of andesite, basalt, rhyolite, quartz, and sandstone.

Cement was manufactured in a plant near Merced from 1927 to 1944. The principal raw materials were mined outside the county. This plant now processes barite from outside areas.

Clay products, brick and building tiles were produced intermittently in plants near Merced until 1931. Local silty clays provided part of the raw material for these products.

Quicksilver was produced intermittently in the Stayton mining district between 1870 and 1946. These deposits consist of cinnabar-filled fractures in basalt and quartz veins, and cinnabar replacements in silica carbonate rock.

A small quantity of hand-sorted antimony ore has also been produced in the Stayton mining district.

A small production of copper was reported between 1901 and 1913 from deposits in the Coast Ranges. A typical Franciscan-type manganese deposit also occurs in the same locality.

Sandstone of the Ione formation has been used locally near Merced Falls for construction purposes. Extensive deposits of Mariposa slate also crop out in this area.

Twenty-eight wildcat wells have been drilled unsuccessfully in search of natural gas and petroleum. Structural or stratigraphic traps underlying the floor of the San Joaquin Valley offer the best possibilities for future discovery.

INTRODUCTION[1]

One day in September 1806, at the end of a tiresome journey, an expedition under Gabriel Moraga arrived at the river now called Merced. Grateful for the respite and refreshment offered by its cooling waters they called it El Rio de Nuestra Señora de la Merced (River of our Lady of Mercy). When Mariposa County was partitioned on April 19, 1855, the part to the west was called Merced after the river of the same name. Later, extensive ranchos were formed most of which were subsequently subdivided into the ranches and farms of the present day.

[1] California Blue Book, p. 905, 1950.

Geography

Merced is a northern San Joaquin Valley country lying near the geographical center of California. It embraces a rectangular-shaped area of 1995 square miles with its long axis trending northeastward and its short axis trending northwestward. Neighboring counties include Stanislaus on the north, Mariposa on the east, Madera and Fresno on the south, San Benito and Santa Clara on the west.

The seat of county government is located in Merced, the principal city, situated on U. S. Highway 99, 131 miles southeast of San Francisco and 275 miles northwest of Los Angeles. It is also the gateway to Yosemite Valley.

The majority of the population is in rural areas; in 1951 the inhabitants of the county totaled 69,780. The important towns on the east side of the valley are: Merced, 15,278; Atwater, 2,856; and Livingston, 1,502. On the west side of the San Joaquin Valley, Los Banos, 3,868; Gustine, 1,984; and Dos Palos, 1,394, are located.

The county has a moderate climate with rainless summers. The mean temperature ranges from 46° Fahrenheit in January to 80° Fahrenheit in July. Average annual rainfall is 11 inches at Merced and 8 inches at Los Banos.

The main lines of both the Atchison, Topeka and Santa Fe and the Southern Pacific railroads provide transportation through the county. An excellent road system, totaling over 2,200 miles traverses the county in all directions.

Topography

The central alluvial plain of the San Joaquin Valley, trending northwestward, occupies about 60 percent of the county's area. Through the middle of this plain the San Joaquin River flows to the northwest. It is fed by the Merced River, its chief tributary, from the northeastern part of the county, and by numerous intermittent streams on both sides of the valley.

Low, rolling foothills of the Sierra Nevada arise from the alluvial plain in the eastern part of the county. The highest elevation reached within the confines of the county border is about 833 feet.

The crest of the northwest-trending Diablo Range, part of the Central Coast Ranges of California, forms the western boundary of the county. The summit of this range and the surrounding vicinity is marked by rugged topography and volcanic peaks. Laveaga Peak at an elevation of 3,801 feet, is the highest point in the county. Eastward, the Diablo Range is separated from the San Joaquin Valley by hills, foothills, and small intervening valleys. The drainage system on the east slope of the Coast Ranges follows a modified dendritic pattern. It is typified by Los Banos Creek, the principal intermittent stream, which has its source in the Stayton mining district.

Industries

Agriculture is the principal industry of the county. Agricultural production in 1949 totaled $80,887,007; the principal products were: field crops, dairy products, beef cattle, fruit and nut crops, and turkeys. Food processing and packaging is the chief manufacturing industry. The preparation of figs, raisin grapes, peaches, tomatoes, sweet potatoes, and milk products for market are included in this category.

GEOLOGY

California is divided into eleven distinctive geomorphic provinces, each of which has certain major geologic features in common. Merced County includes three of these provinces, the Great Valley of California, the Coast Ranges, and the Sierra Nevada.

Great Valley of California. The Great Valley of California is an alluvial plain, 400 miles long by 50 miles wide, in the central portion of the state. The San Joaquin Valley forms the southern half of this province. The Great Valley is underlain in the west by eastward dipping Cretaceous and Cenozoic rocks of the Coast Ranges, and in the east by the Sierra Nevada bedrock series. This valley is drained by the Sacramento and San Joaquin Rivers which discharge into San Francisco Bay.

Sierra Nevada. The Sierra Nevada is a complex structure but is essentially a westward tilted fault block nearly 400 miles long. The range is composed of slates, schists, gneisses, and intruded igneous rocks upon which lie, unconformably, a series of late Cretaceous and Tertiary sediments and volcanic rocks. The Cretaceous and Tertiary rocks, which are nearly flat-lying and unmetamorphosed, have been called the ''Superjacent Series'' in older reports, while the much-folded and metamorphosed older formations have often been referred to as the ''Bedrock Series''.

Coast Ranges. The Coast Ranges are a system of longitudinal, northwestward striking mountains which are composed of late Mesozoic and Cenozoic sediments, metasediments, and associated intrusive and extrusive igneous rocks.

West Side

Rock Formations

Franciscan Formation (Upper Jurassic (?)). The Franciscan formation comprises the oldest rocks found in the western portion of Merced County. This formation is a very thick assemblage of sedimentary, igneous, and metamorphic rocks. The sedimentary rocks consist of arkosic sandstone, shale, chert, partly metamorphosed arenaceous and argillaceous material, and minor amounts of conglomerate. Basic igneous intrusions of late Jurassic (?) age which were predominantly peridotite and gabbro, have since been largely altered to serpentine.

Franciscan rocks in the Ortigalita Peak and Quien Sabe quadrangles of western Merced County have been thrust eastward over the younger Cretaceous sediments along the Ortigalita thrust fault.

Panoche Formation (Upper Cretaceous). The Panoche formation, approximately 25,000 feet thick, consists essentially of arenaceous shale and thinly bedded sandstone. Massive and concretionary sandstone weathers out prominently from the softer beds of the formation. Buff-colored cavernous exposures are the result of weathering of limy, concretionary, gray biotitic sandstones. Lenses of coarse-grained conglomerate that contain boulders, cobbles, and pebbles of porphyritic and granitic rocks, some quartz and quartzite, sandstone, limestone, and fossiliferous boulders, occur in the sedimentary sequence of the Panoche formation. Although many strata are fossil bearing throughout the

Panoche, few are abundantly so. The age of the fossils places the Panoche formation as Upper Cretaceous.

Moreno Formation (Upper Cretaceous). The Moreno formation, approximately 4,000 feet thick, conformably overlies the Panoche and is characterized by a maroon, chocolate-brown, or purplish-colored organic shale, which weathers to very thin platy fragments or pencil-sized splinters. The shale is intricately veined with gypsum and contains a diatomaceous member. Fossil mollusks have been found in white oval-shaped limestone concretions. Sandstone members of this formation occur as massive lenses and as thin beds laminated with shale and siltstone. Conglomeratic sandstone containing fossils is found in several zones. Some small sandstone dikes are also found in the Moreno. Part of the upper part of the Moreno formation, mapped as a lithologic unit, probably was deposited in the Paleocene epoch.[2]

Martinez Formation (Paleocene). The Martinez formation was mapped and described by Anderson and Pack[3] and Briggs.[4] The 1200-foot-thick formation overlies conformably the Moreno, showing a gradational contact. White to dark gray siltstone, clay shale, and fine-grained arkosic sandstone are the predominating components of the Martinez. Abundant gypsum occurs locally and glauconite is abundant throughout the sedimentary sequence. Many of the dark brown concretions, some as large as 3 feet in diameter, are filled and coated with gypsum. Petrified logs and some marine fossils are distributed throughout the formation.

Undifferentiated (Paleocene-Eocene). An outcrop of undifferentiated beds stratigraphically between the Martinez and Tesla formations is shown in the northern part of the map (pl. 12), near the Stanislaus County boundary.

Tesla (?) Formation (Middle (?) Eocene). The topographically resistant uppermost sandstone beds of the rocks of Paleocene age and the softer sandstone, kaolinitic clay, and brown shale beds of the conformably overlying Tesla formation,[5] aid in delineating the exposed contact between them. A few poorly defined fossils were found in the formation, but determination of the age of the formation is based on stratigraphic relationship. Biotite, muscovite, and glauconite constitute distinctive subordinate minerals in some of the sandstone beds. Local lenses of conglomerate and one very small zone of tuffaceous sandstone were also noted in the formation.

Kreyenhagen Formation (Upper Eocene). The white, diatomaceous and foraminiferal shale and clay of the 950-foot-thick Kreyenhagen beds exhibit a striking contrast to the dull-colored underlying formations and the overlying San Pablo beds. The Kreyenhagen formation consists of

[2] Payne, M. B., Type Moreno formation and overlying Eocene strata on the west side of the San Joaquin Valley, Fresno and Merced Counties, California: California Div. Mines Special Rept. 9, 1951.

[3] Anderson, R. and Pack, R. W., Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 1915.

[4] Briggs, L. I. Jr., Geology of the Ortigalita Peak quadrangle, California: unpublished thesis, University of California.

[5] Huey, A. S., Geology of the Tesla quadrangle, California: California Div. Mines Bull. 140, p. 33, 1948.

diatomaceous shale, slightly carbonaceous clay shale, fine-grained sandstone, and a basal member of glauconitic sand. Innumerable veinlets and plates of selenite are dispersed throughout the formation, and extensive deposits of efflorescent gypsum several feet in thickness are found on the flat hilltops. Fossil fish scales and shark teeth have been found in the upper part.

San Pablo Formation (Upper Miocene). Disconformably overlying the Kreyenhagen, the varicolored tuffaceous San Pablo is composed mainly of a bentonitic, locally iron-stained conglomerate, some white clayey sandstone and pale green clay strata. Poorly defined pelecypod casts have been found in the lowest part of the San Pablo beds.

Ora Loma Formation (Lower or Middle Pliocene). Beds composed essentially of deep reddish-colored, poorly consolidated silts, sands, and gravels stratigraphically between the San Pablo and Tulare formations have been called the Ora Loma formation by Briggs in an unpublished paper.[6] Because no fossils were found in the beds their age has been inferred from stratigraphic position as lower or middle Pliocene.

Tulare Formation (Plio-Pleistocene) and Quaternary Terrace Deposits. The almost horizontal Tulare formation unconformably overlies all of the older units. Its thickness ranges from 100 to 500 feet. The source of the Tulare detrital material, which ranges from silt to boulders, has been rocks of the Franciscan group.

Stream terraces are the old sedimentary deposits of the streams when they were at different levels. On the accompanying geologic map of Merced County, some of the contacts between the stream terraces and the Ora Loma formation are arbitrarily placed because of the difficulty in distinguishing the two units.

Lake Beds (Upper Pleistocene). The lake beds, which have been called the Peckham formation by Leith,[7] consist of poorly cemented, well-rounded pebble and boulder gravels of igneous and Franciscan origin. These gravels, which have a maximum thickness of 300 feet, are interbedded with silt, sand, and clay; cross-bedding, stratification, lensing, channeling, and lacustrine limestone are indicative of deposition by water. The deposition probably occurred in a lake during the upper part of the Pleistocene epoch.

Recent Alluvium. Recent alluvium, derived from the topographically higher western areas, masks all older formations along the west side of the San Joaquin Valley.

Tertiary Volcanic Rocks. The Tertiary volcanic rocks that occur in Merced County include the Miocene Quien Sabe volcanic rocks, discussed by Leith,[8] and the volcanic rocks discussed by Anderson and Pack.[9] Among the volcanic rocks are pink to gray andesite and white to gray rhyolite, dark gray to black basalt, and limonite-stained pumiceous material. They occur in the western part of Merced County as flows, agglomerates, dikes, and plugs. In some places the flows and agglomer-

[6] Briggs, L. I. Jr., op. cit.

[7] Leith, C. J., Geology of the Quien Sabe quadrangle, California: California Div. Mines Bull. 147, pp. 26-27, 1949.

[8] Leith, C. J., op. cit., pp. 22-26.

[9] Anderson, R. and Pack, R. W., op. cit.

FIGURE 1. Unconformity between Jurassic slate and Eocene sandstone. Photo taken along strike of nearly vertical slightly west-dipping Mariposa slate. Slate is covered by talus slope formed by weathering of overlying quartz-anauxite sandstone of Ione formation.

ates form rugged outcrops having vertical faces 50 feet or more in height. A remnant basalt flow occurs on top of Basalt Hill; this hill appears to have been the vent from which the basalt was extruded.

East Side

Rock Formations

Mariposa Formation (Upper Jurassic). The Mariposa formation is composed predominantly of dark clay slates with a subordinate amount of sandstone and conglomerate. The formation has a general northwesterly strike and a high angle of dip to the northeast because of the high degree of metamorphism during the Sierra Nevada orogeny. Post-Jurassic sedimentary and volcanic rocks unconformably overlie the upturned, truncated edges of the slates. Some fossils have been found in this formation.

Ione Formation (Eocene). The Ione formation is a soft, light-colored, massive quartz-anauxite sandstone. In some places the formation forms flat-topped hills. Although the beds appear to be horizontal, they actually have a very slight dip to the west.

Valley Springs Formation (Middle (?) Miocene). The Valley Springs formation, which unconformably overlies the Ione, is composed almost entirely of fragmental, glassy rhyolitic conglomerate and tuffs. Quartz-anauxite sandstone that occurs in the lowest part of the formation, is interbedded with rhyolite tuff and pumice-bearing clay. Because no fossils have been found in this formation, its age has been assigned to middle (?) Miocene on the basis of stratigraphic relationships.

Mehrten Formation (Upper (?) Miocene and Pliocene (?)). The Mehrten formation, which unconformably overlies the Valley Springs formation, is a fluviatile deposit consisting essentially of andesitic detri-

tus with minor amounts of Sierra Nevada metamorphic and igneous rocks. The deposit includes sandstone, siltstone, conglomerate, and fragmental andesitic breccia and tuff. Fossil plants found in the Table Mountain area in Tuolumne County in this formation were determined to be of Miocene age by Lindgren [10] and Knowlton.[11] VanderHoof [12] has described a vertebrate fossil from a clay lens which he found to be earliest Pliocene in age.

Quaternary Deposits. During late Quaternary time, fine-grained sediments, sands, and gravels were deposited in most of the river bottoms and valleys.

Granitic Intrusions. Granite, granodiorite, and related rocks, which form the core of the Sierra Nevada, were intruded into the sedimentary rocks of the Mariposa formation, probably in late Jurassic time. Their intrusion presumably accompanied the Jurassic orogeny. The weathered products from these intrusive igneous rocks constituted a major part of the later Tertiary formations.

Inferred Geology Below Valley Floor

The San Joaquin Valley is a geosyncline with a northwest-trending axis along the west side of the valley. The valley measures approximately 250 miles long and averages about 55 miles wide. It is underlain by sediments, predominantly marine sands and shales, which range in age from Cretaceous to Quaternary. The basement rocks include all the igneous and metamorphic rock types of pre-early Cretaceous time. The Franciscan group underlies the western portion of the valley while the Sierra Nevada granitic complex underlies the eastern portion; the relationship between the two is unknown. Very little is known about the extent and form of the basement complex because of the overlying sedimentary beds. Few deep tests have penetrated the entire Cretaceous and very few holes have exceeded 10,000 feet in depth. Cretaceous-Cenozoic sediments are probably 30,000 feet thick in the trough of the geosyncline.

Geologic History

During late Jurassic time, an open sea extended as far east as Nevada and covered what is now Merced County. Toward the end of this period sediments worn from a large landmass which lay to the west of the present California shoreline were being deposited in a sinking geosynclinal basin extending the entire length of the present Coast Ranges. It is assumed that this same western landmass also contributed sediments to the Mariposa formation in the Sierra Nevada. The Franciscan and Mariposa formations represent the oldest rocks which crop out in Merced County.

Near the end of the Jurassic, orogenic processes in the Coast Ranges and the Nevadan orogeny in the Sierra Nevada, accompanied by basic and ultrabasic intrusions into the sediments, caused an almost complete withdrawal of the sea from the Great Valley area. A period of extensive erosion followed in early Cretaceous time.

[10] Lindgren, Waldemar, The Tertiary gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, pp. 52, 56-57, 1911.
[11] Knowlton, F. H., Flora of the auriferous gravels of California, in Lindgren, Waldemar, The Tertiary gravels of the Sierra Nevada of California: U. S. Geol. Survey Prof. Paper 73, pp. 57-64, 1911.
[12] VanderHoof, V. L., A skull of *Pliohippus tantalus* from the later Tertiary of the Sierran foothills of California: California Univ., Dept. Geol. Sci. Bull., vol. 23, pp. 183-194, 1933.

In the Upper Cretaceous epoch, the sea again advanced over Merced County, but at this time, its eastern shoreline was west of the newly elevated Sierra Nevada and probably covered the present area of the Great Valley of California. The early part of the Tertiary period brought further mild uplifting with continued erosion in a climatic setting which was, at times, semi-tropical. Marine deposition characterized the Miocene in the Coast Ranges and western valley area and extensive volcanic activity took place in both the Coast Ranges and the Sierra Nevada, diminishing in the Pliocene. Continental sediments (Tulare) were deposited in late Pliocene time in the Coast Range area with the beginning of Plio-Pleistocene mountain-building. The fossilized flora and fauna suggest that a cooler climate began to develop in upper Pliocene, presaging the Pleistocene glaciers.

Late Piocene-early Pleistocene time was a time of major folding, faulting, and uplift in the Coast Ranges and of extensive broad uplift in the Sierra Nevada. In this orogenic period, thrust-faulting (i.e., Ortigalita thrust) was important in the Coast Range province. Glaciers developed in the re-elevated Sierra Nevada but did not advance far enough down the western Sierra Nevada slope to reach Merced County. Introduction of the early part of the Recent epoch saw retreat of the glaciers from the Sierra, and the final development of the present landscape and climate.

ECONOMIC GEOLOGY AND MINERAL RESOURCES

Merced County's total recorded mineral production, 1880-1949, is valued at $32,044,600. In addition, mercury (quicksilver) valued at $133,586, was produced from mines in the Stayton district located within Merced's borders. Nearly all of the quicksilver was transported to market through Hollister, and the value of this production was credited to San Benito County.

FIGURE 2. Diatomite beds in roadcut. Camera facing west toward northeast-dipping diatomite.

Table 1. Mineral production of Merced County, 1880-1949.

Year	Gold, value	Silver, value	Copper		Brick		Miscellaneous and unapportioned		
			Pounds	Value	M	Value	Amount	Value	Substance
1880	$17,515								
1881	1,500								
1882	10,000								
1883	10,000								
1884	6,500								
1885	10,000								
1886	7,000								
1887	10,767	$5							
1888	10,000								
1889	4,843								
1890	2,000	59							
1891	1,728	17							
1892	445								
1893									
1894	763								
1895	1,500								
1896	1,250								
1897									
1898									
1899									
1900	[1]								
1901	[1]		79,071	$12,453					
1902			14,400	1,656					
1903	[1]		6,000	780					
1904	[1]		8,900	1,135					
1905	[1]				600	$3,500			
1906					650	6,000			
1907	822	10			1,250	12,500			
1908	[2]182,970	[2]1,196	694	70	700	6,300	965 lbs.	$36	Lead.
1909	[2]228,492	[2]572			700	6,300		18,264	Unapportioned.
1910	[1]	[1]			700	6,300		64,764	Miscellaneous stone.
1911	[1]	[1]						49,548	Miscellaneous stone.
1912	[1]	[1]						45,000	Miscellaneous stone.
1913	[4]2,255	[4]92	19,240	2,982				30,000	Miscellaneous stone.
1914	[2]111,361	[2]340							
1915	[3]	[3]					690 lbs.	32	Lead.
								94,000	Other minerals.
1916	[3]	[3]					90 tons	720	Magnesite.
								80,810	Gold, platinum, silver.
1917	[3]	[3]						70,500	Miscellaneous stone.
								76,616	Gold, platinum, silver.
1918	41,089	254						32,500	Miscellaneous stone.
								1,006	Other minerals.
1919	[1]	[1]						40,350	Miscellaneous stone.
1920								24,800	Miscellaneous stone.
1921	3,163	87						30,300	Miscellaneous stone.
1922	[3]	[3]			[3]			88,110	Miscellaneous stone.
								69,469	Building tile, gold and silver.
1923	[3]	[3]			[3]			134,036	Miscellaneous stone.
								101,567	Brick, building tile, gold and silver.
1924	355	1	[3]		[3]			14,262	Miscellaneous stone.
								72,933	Clay and clay products.
								52	Copper and lead.
1925	289	1			[3]			36,646	Miscellaneous stone.
								43,326	Clay and clay products.
1926					[3]			156,486	Miscellaneous stone.
								36,179	Clay and clay products.
1927					[3]			189,537	Miscellaneous stone.
								177,336	Brick, hollow building tile, cement, clay (pottery).

Table 1. Mineral production of Merced County, 1880-1949—Continued.

Year	Gold, value	Silver, value	Copper		Brick		Miscellaneous and unapportioned		
			Pounds	Value	M	Value	Amount	Value	Substance
1928	$310	$2				[3]		$652,875	Other minerals.[6]
1929	84,188	186				[3]		1,026,124	Other minerals.[7]
1930	88,328	146				[3]		29,250	Miscellaneous stone.
								684,176	Other minerals.[8]
1931	173,551	226						534,012	Other minerals.[9]
1932	391,017	525						22,500	Miscellaneous stone.
								335,700	Other minerals.[10]
1933	451,023	610						13,875	Miscellaneous stone.
								300,506	Other minerals.[11]
1934	598,695	1,051						38,643	Miscellaneous stone.
								412,103	Cement, gypsum, platinum.
1935	1,302,369	2,761						14,750	Miscellaneous stone.
								384,895	Other minerals.
1936	1,462,160	3,433						20,755	Miscellaneous stone.
								522,960	Cement, copper, lead, platinum.
1937	1,858,815	4,274						36,157	Miscellaneous stone.
								635,880	Other minerals.
1938	2,090,340	3,788						139,637	Miscellaneous stone.
								633,736	Other minerals.
1939	1,781,325	3,219						827,352	Cement, miscellaneous stone, platinum.
1940	1,816,745	3,478						694,100	Cement, miscellaneous stone, platinum.
1941	1,550,955	3,237						101,687	Miscellaneous stone.
								924,105	Other minerals.
1942	701,855	1,381						184,196	Miscellaneous stone.
								960,887	Other minerals.
1943	2,835	20						1,115,458	Cement, platinum, miscellaneous stone.
1944	175							853,730	Sand, gravel, and other minerals.
1945	51,765	99						233,499	Sand and gravel.
1946	130,620	276						190,262	Sand and gravel, and other minerals.
1947	[3]	[3]						742,366	Gold, crude platinum metals, sand, gravel, and silver.
1948	[3]	[3]						869,757	Gold, crude platinum metals, sand, gravel, and silver.
1949	[3]							834,482	Gold, sand, gravel.
Totals	$15,203,678	$31,346	128,305	$19,076	4,600	$40,900		$16,749,600	
Grand total value								$32,044,600*	

* Quicksilver mining began in the Stayton district between 1870 and 1880. Since most of the shipments were made through Hollister, San Benito County received credit for all this production. Records indicate the quicksilver mines in Merced County produced 1605 flasks, valued at $133,586.

[1] Included with Stanislaus County production.
[2] Includes Stanislaus County production.
[3] See under 'Unapportioned.'
[4] Dredge output included under Stanislaus County.
[6] Includes brick and hollow building tile, cement, clay (pottery), miscellaneous stone.
[7] Includes brick and hollow building tile, cement, miscellaneous stone.
[8] Includes brick and hollow building tile, clay (pottery), lead.
[9] Includes cement, copper, miscellaneous stone.
[10] Includes cement, platinum, volcanic ash.
[11] Includes cement, gypsum, platinum.

Merced County ranked thirty-fourth among California's 58 counties in value of mineral production in 1949. The principal items produced were gold, crude platinum metals, gypsite, sand, gravel, and silver. Mineral commodities that year were valued at $834,482. Peak mineral production was attained during 1938 when the value was recorded as $2,867,501, ranking the county fourteenth in the state.

Antimony

Antimony deposits in the Stayton mining district were first mined about 1870. The district was organized shortly thereafter and embraces that part of western Merced County in the SW¼ T. 11 S., R. 7 E. and in the NW¼ T. 12 S., R. 7 E., M. D. Tertiary igneous extrusive and intrusive rocks ranging from basalt and andesite to rhyolite crop out throughout the area. The ore, consisting of stibnite, Sb_2S_3, in quartz veins, occurs along faults trending northward and the majority of the orebodies are in basaltic rocks. Bailey and Myers[13] studied the deposits and estimated the ore reserves at "a few tens of thousands of tons" of "ore averaging less than 1½ percent." They discussed the three antimony mines from which a small production has been made. One of these mines, the Blue Wing, is in Merced County and their description of it is quoted below.

"The Blue Wing mine, owned by Mr. R. B. Knox, is in sec. 5 T. 12 S., R. 7 E., a few hundred yards southwest of the Stayton mine. It is belived to have produced a few tons of hand-sorted ore. As the mine is now flooded the following information is that offered by Mr. Knox, supplemented by the authors' examination of the rock on the small dump.

"The workings consist of a vertical shaft approximately 75 feet deep with a drift to the north and a short, shallow drift to the south. The ore is in northward-trending quartz-stibnite veins in basalt. The vein is apparently discontinuous, but locally it contains lenses of nearly pure stibnite slightly less than a foot thick. Cinnabar was found in vugs and along fractures in the upper 20 feet of the stibnite vein, but it did not occur below this level.

"The vein was carefully prospected a few years ago, and at that time was considered of too low grade to be worked for either antimony or quicksilver. A few tons of ore containing nearly 50 percent of stibnite remains on the dump."

Cement[14]

Cement was manufactured by the Yosemite Portland Cement Corporation in a plant 2 miles north of Merced on the Snelling road. The plant began operating in 1927 and production was reported continuously until 1944 when the company was liquidated. Cement was made by the wet process and burned in three kilns 160 by 8 feet in size. Limestone was obtained from the Jenkins Hill quarry in Mariposa County and most of the clay used in the process was obtained from the Ione district, Amador County. Rated capacity was 2,000 barrels per day. Finished cement was originally delivered to two banks of three reinforced concrete silos, each 30 feet in diameter and 90 feet high with a capacity of 90,000 barrels of cement. Later, two banks of 4 silos of the same size were added to the plant. The storage units were the only part of the plant remaining in 1951. These and warehouse facilities were leased to the Baroid Sales Division, National Lead Company.

---

[13] Bailey, E. H. and Myers, W. B., Quicksilver and antimony deposits of the Stayton District, California: U. S. Geol. Survey Bull. 931Q, 1942.
[14] Laizure, C. McK, Merced County: California Min. Bur. Rept. 21, no. 2, p. 177, 1925.

Clay

Small quantities of sandy and silty clay of local origin were used many years ago in the manufacture of common brick. These clays were mined from shallow pits sunk in the Quaternary alluvial deposits covering the central part of the county near Merced. Plants for the manufacture of cement, drain tile, roofing tile, and hollow building tile [15] were also formerly located near this city. Operators of the plants had hoped to discover deposits of high-grade clay in their vicinity, but were eventually forced to import the major portion of their crude requirements from Amador and Calaveras Counties.

The Ione formation of Eocene age overlies the members of the bedrock complex in the foothills of the Sierra Nevada. The Ione was first discussed by Lindgren [16] who stated: "The white clays of the Ione formation are frequently well suited to the manufacture of pottery. This industry is at present extensively carried on near Lincoln (Placer County), where local conditions permit the clays to be quarried with little expense."

Remnants of the Ione formation were mapped by Allen [17] in the eastern foothills of Merced County. He states:

"The Ione formation is exposed along the Merced River in the Sonora quadrangle near Merced Falls. Massive quartz-anauxite sandstone forms the flat topped hills south of town. . . . At the sharp bend of the Merced River southwest of Merced Falls, massive layers of 'clay rock' form the upper twenty feet of the exposure and rest on Ione sands. In places, its contact with the Ione is irregular and sharp but farther west the base locally contains much sand and a few fragments of 'clay rock' and these alone make the distinction from the Ione possible. A short distance downstream the 'clay rock' thickens to forty feet at the expense of the Ione, and less than half a mile farther west it appears at stream level and forms the entire bank. Some of the massive layers dip southwest 12° to 18°, and in some the tuffaceous character can be easily made out. Gravels form a small fraction of the series. The 'clay rock' and tuffs can be followed eastward toward the upper fossiliferous sandstone forming the buttes, but they end before it is reached. It would appear that the upper Ione sandstone was eroded from the area along the river before the 'clay rock' was deposited, and that erosion was caused by uplift which prevented the rhyolitic tuff series from reaching as far east or to the same elevation as the Ione.

"The 'clay rock' considered by Turner the uppermost division of the Ione formation is separated from the lower two divisions by a disconformity, and differs from them chemically, mineralogically, and in mode of origin. Turner and Dickerson considered the 'clay rock' to be an altered rhyolitic tuff, and the present writer agrees with them. In many respects the 'clay rock' is less closely related to the underlying Ione sediments than to the overlying rhyolite tuffs. Turner did not include some rhyolite tuffs in the Ione formation, but mapped them separately. In so doing, he recognized that the rhyolite tuffs were different from the lower Ione sediments, but the line of division selected by him was certainly not the best. The writer believes that the disconformity observed at several places constitutes the only satisfactory line of demarcation, for it separates the anauxite clays and sands that occur near the town of Ione from the 'clay rock' and the overlying tuffs. Because of the difference in age and in composition, the 'clay rock' should no longer be considered a part of the Ione formation, but should be assigned to the rhyolitic tuff period.

"The 'clay rock' is described by Turner as a light gray, but often discolored rock, with an irregular fracture and containing tubular passages, and is composed of fine particles of feldspar, fine discolored sediment, and occasional quartz grains."

---

[15] Dietrich, W. F., The clay resources and the ceramic industry of California: Calif. Div. Mines Bull. 99, p. 127, 1928.

[16] Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Sacramento Folio (no. 5), p. 3, 1894.

[17] Allen, Victor T., The Ione formation of California: Univ. Calif. Dept. Geol. Sci. Bull. 18, no. 14, pp. 361 and 413, 1929.

The above discussion indicates that the deposit of "clay rock" formerly reported from this area is actually a deposit of rhyolite tuff.

Copper

Copper deposits carrying native copper and chalcopyrite have been described in earlier reports.[18] These deposits are located in the Coast Ranges in the southwestern part of the county in T. 13 and 14 S., R. 9 E., and in T. 13 S., R. 10 E., M. D. Additional deposits have been reported from the southeastern part of the county near Le Grand, but their location is indefinite and the topography of the area suggests that the properties are in Mariposa County.

Table 1 shows that a small copper production was recorded from 1901 to 1904 inclusive, in 1908, and in 1913. Total recorded production was 128,305 pounds of copper valued at $19,076.

Diatomite[19]

Diatomite or diatomaceous earth is a light-colored, light-weight sedimentary rock. It is composed chiefly of the shells or outer coverings of silica-secreting plants of microscopic size called diatoms. The impure varieties of diatomite commonly contain clay, silt, fine sand, limestone, thin beds of volcanic ash, and chert. Gradations from pure diatomite and diatomaceous shale, to clay shales and siltstones are found. All contain some diatoms. Bramlette [20] believes that the silica required to form the diatoms was derived from the finely divided particles of volcanic ash which are always found associated with the diatomite beds. Diatomite is used chiefly for filtration, insulation, and fillers.

Diatomite occurs in the Coast Ranges foothills of southwestern Merced County. It is found in the Kreyenhagen shale of upper Eocene age which extends southeastward from Ortigalita Creek for a distance of 6 miles. In this vicinity the Kreyenhagen is 950 feet thick, strikes N. 42° W. and dips 42° NE. One prominent outcrop of diatomite is located in the NE$\frac{1}{4}$ sec. 2, T. 12 S., R. 10 E., M.D. Here, an efflorescent deposit of gypsite caps the diatomite, and commercial development of the gypsite is in progress. Diatomite also occurs in the upper part of the Moreno formation (Upper Cretaceous) southeast of Ortigalita Creek.[21]

Gold

The beds of practically all the streams entering eastern Merced County from the Sierra Nevada contain some gold. The most important concentrations, however, were made throughout the alluvial plain of the Merced River between Merced Falls and Snelling, and nearly all the gold recovery has been made in this area. Undoubtedly the gold was derived from the pocket belt of the Mother Lode in Mariposa County, which is traversed by the upper course of the Merced River. A moderate

[18] Jenkins, Olaf P., Copper in California : Calif. Div. Mines Bull. 144, p. 272, 1948.
Laizure, C. McK, op. cit., p. 179, 1925.
Aubury, L. E., The copper resources of California : Calif. Div. Mines Bull. 50, p. 171, 1908.

[19] Oakeshott, G. B., Diatomite : Calif. Div. Mines Bull. 156, p. 150, 1950.

[20] Bramlette, M. N., The Monterey formation of California and the origin of the siliceous rocks : U. S. Geol. Survey Prof. Paper 212, 1946.

[21] Anderson, R. and Pack, R. W., op. cit. p. 211, 1915.

Summary of Economic Geology of Merced County.

Era	Geologic age	Formations: West side of valley	Formations: East side of valley	Distribution	Rock types	Mineral deposits
QUARTERNARY	Recent	Alluvium	Alluvium	Thick in San Joaquin Valley	Assemblage of sands, gravels, and silts, derived from igneous, metamorphic, and sedimentary rocks	Sand and gravel; placer gold, silver, platinum; silty clay
		Landslides		Stayton district area	Franciscan shale and sandstone; Tertiary volcanic rocks	
	Pleistocene	Peckham		Isolated patches along south fork of Los Banos Creek	Fresh water lake beds of gravel, sand, silt, and limestone	
		Tulare		Flat-lying patches which mask older formations	Terrace deposits of sand, silt, gravel, and marl(?)	Possible source of marl for agricultural lime
TERTIARY	Pliocene	Ora Loma		Belt bordering valley and foothills near Hamburg Ranch	Gravel, sand, silt, and local conglomerate	
	Miocene	Quien Sabe		Covers extensive area in Stayton mining district	Volcanic rocks: andesite and basalt flows; agglomerates, conglomerates, and tuffaceous sandstones, andesitic intrusive plugs; hydrothermally altered rhyolite intrusives	Quicksilver, antimony
			Mehrten	Forming first of the lowlands of the Sierra Nevada	Andesitic gravels	
		San Pablo		Belt bordering valley and foothills near Hamburg Ranch	Tuffaceous conglomerate and clayey sandstone	
			Valley Springs	Northeastern corner of county in the vicinity of Merced Falls and Snelling	Rhyolitic conglomerates and tuffs, pumice, and clay	
		Kreyenhagen		Belt bordering valley and foothills near Hamburg Ranch	Diatomaceous shale and sandstone.	Gypsite, diatomite; some marl; possible source of natural gas and petroleum
		Tesla		Belt about 1/5 mile wide bordering valley and foothills near Hamburg Ranch	Sandstone, clay, shale, and conglomerate	
	Eocene		Ione	Slightly dipping beds cropping out in vicinity of Merced Falls	Quartz-anauxite sandstone	Used as building stone
	Paleocene	Martinez		Occurs as belt ½ mile wide in the southwestern portion of the county	Fine-grained arkosic sandstone	
MESOZOIC	Upper Cretaceous	Moreno		As a belt 1 mile wide in the southwestern corner of the county	Organic shale with some concretionary and lenticular sandstone	Argillaceous diatomite; some gypsite; possible source of natural gas and petroleum
		Panoche		A wide belt in western Coast Range foothills	Arenaceous shale, sandstone, lens of conglomerate	
	Upper Jurassic		Mariposa	On eastern border as a narrow belt in the vicinity of Merced Falls	Slate with some sandstone and conglomerate	Slate
		Franciscan		As a wide band along western portion of county	Arkosic sandstone, shale, chert, conglomerate, meta-sediments; basic intrusives and serpentine	Quicksilver, copper, manganese

amount of gold placer mining was done near Snelling in the early days. The record of mineral production shown in table 1 indicates that small quantities of gold were recovered in all but 6 years of the 27-year period between 1880 and 1907.

A second phase in the history of the area began late in 1907. At that time the Yosemite Mining and Dredging Company began operating the first connected-bucket dredge in the county.[22] The value of gold recovered during the first complete year of operation was about double the total previously reported production. These operations continued successfully until 1919 when the dredging of the tract was completed.

A procession of rising costs in labor and supplies occurred during the next 10 years as a result of World War I. The effect was depressing to gold mining, and consequently only a series of intermittent small scale operations were recorded during this interval.

The truly golden period of production began in 1929 when a connected-bucket dredge began operating 4 miles east of Snelling. A second dredge "started up" in 1932. By this time a series of economic events resulted in an increased labor supply and a marked lowering of operating costs. In 1934, the revaluation of gold increased the purchasing power of this commodity and acted as an added stimulus to increased production.[23] Three new connected-bucket dredges were placed in operation in 1935 and the value of gold production passed the million dollar mark for the first time in the history of the county. Another similar dredge was added in 1937, and in 1938 the value of gold production passed the two million dollar mark—an all time high for the county. For 7 years, from 1935 to 1941 inclusive, the value of gold production exceeded the million dollar mark.

This lucrative period of production was suddenly terminated by governmental edict. The advent of World War II was accompanied by War Production Board's Limitation Order L-208 issued on October 8, 1942. By October 15, 1942, all the dredges had suspended operations. In 1943 the value of gold production had fallen to $2835.

An attempt was made on July 15, 1945, to resume dredging operations in the face of rising costs following World War II. Another governmental hurdle was immediately presented on September 1945 in the form of resoiling ordinance no. 253 passed by the Merced County Board of Supervisors. The Merced Dredging Company then filed an injunction against the ordinance but no action resulted for nearly a year, and the dredge remained inactive. Finally an injunction was granted and dredging was resumed on September 6, 1946. The ordinance was amended by ordinance no. 263 passed on August 19, 1946. The net result, however, was unfavorable to dredging and only three of the connected-bucket dredges resumed operations. By July 1951 only one connected-bucket dredge remained in operation, and the property available to this dredge was rapidly nearing exhaustion.

Since there has been considerable interest in ordinances regulating mining and dredging operations, a copy of the ordinance is reproduced below.

[22] Winston, W. B. and Janin, C., Gold dredging in California: Calif. Div. Mines Bull. 57, p. 211, 1910.
[23] Joslin, G. A., Gold: Calif. Div. Mines, Bull. 130, p. 129, 1945.

ORDINANCE No. 253

County of Merced, State of California

PASSED AND ADOPTED BY THE BOARD OF SUPERVISORS ON THE 1ST DAY OF SEPTEMBER, 1945. AS AMENDED BY ORDINANCE NO. 263, ADOPTED BY THE BOARD OF SUPERVISORS ON THE 19TH DAY OF AUGUST, 1946.

AN ORDINANCE TO REGULATE SURFACE MINING OPERATIONS AND THE USE THEREIN OF DREDGERS, DRAG LINES AND OTHER EARTH MOVING EQUIPMENT; PRESCRIBING CERTAIN CONDITIONS AS PUBLIC NUISANCES; REQUIRING THE FILING OF APPLICATIONS FOR PERMITS TO SURFACE MINE, THE ISSUANCE OF PERMITS THEREFOR, AND THE FILING OF SURETY BONDS OR DEPOSITS OF CASH IN LIEU THEREOF; PROVIDING FOR TERMINATION OF SUCH PERMITS IN CERTAIN CASES; DECLARING SUCH ORDINANCE AN URGENCY MEASURE; PROVIDING THAT ANY VIOLATION THEREOF IS A MISDEMEANOR; AND PROVIDING FOR AND PRESCRIBING PENALTIES FOR VIOLATION THEREOF.

The Board of Supervisors of the County of Merced, State of California, do ordain as follows:

Section 1. Definitions

As used in this ordinance, the following definition of terms shall apply:

(a) "Top soil" shall mean all of that portion of the top surface of the earth which has supported, or is capable of supporting plant life.

(b) "Fine material" shall mean all of the material which is washed or processed for the recovery of minerals.

(c) "Coarse material" shall mean all of the remainder of the rocks and soil displaced by dredging or washing operations.

(d) "Parcel" shall mean contiguous land in one ownership.

(e) "Person" shall mean any person, firm, or corporation.

Section 2. Dredging Operations, Replacement of Displaced Material

All surface mining operations in the County of Merced, State of California, involving the use of dredgers, drag lines, or other soil moving devices which displace rocks or soil, or both, on the earth's surface, shall be conducted in such manner as to replace the rocks and soil displaced by their operations. The materials displaced, except the top soil, shall be replaced in the excavation. The top soil shall be replaced on top of the other material. Prior to replacing the top soil the other displaced material shall be left in a substantially level condition and the top soil, when replaced, shall be left in a substantially level condition.

(As amended by Ord. 263.)

Section 3. Stripping of Top Soil

Prior to the commencement of any such mining operations the top soil shall be stripped from the surface of the land proposed to be disturbed, provided that when said top soil exceeds a depth of three feet, only the top three feet thereof need be stripped as herein provided.

Section 4. Releveling Requirements

Whenever any person is conducting mining operations pursuant to a permit issued hereunder he shall not permit to remain unleveled and without the top soil replaced thereon at any time more than fifty acres in area of the land involved for each dredger, drag line, or other unit of soil moving device used by him in the conduct of such operations. The Board, on hearing as provided in Section 5 hereof, may permit a greater acreage of dredged land to remain unleveled at any one time.

(As amended by Ord. 263.)

Section 5. Application for Exemption From Resoiling

When, in the opinion of the Board of Supervisors of the County of Merced, State of California, the present or probable future agricultural value of the land involved does not justify such leveling or resoiling, said Board may exempt such land in whole or in part and upon such reasonable terms and conditions as said Board may prescribe from all or any of the provisions of this ordinance relating to the stripping of top soil, the leveling of replaced material and the replacement of top soil. Application for such exemption shall be in writing and presented at a regular public meeting of such Board of Supervisors, or at a special meeting called for that purpose, at which meeting a time and place for hearing such application shall be fixed by such Board of Supervisors. The hearing on such application shall be fixed for and held at a regular or special public meeting of such Board of Supervisors and shall be held not sooner than ten (10) days, nor more than thirty (30) days, after the presentation of such application. The Board of Supervisors at such meeting, or within ten (10) days thereafter, shall approve or disapprove the application under such terms and conditions as it shall determine to be proper.

In the event of the disapproval by said Board of said application, the grounds of disapproval shall appear in the minutes of the meeting of the Board at which such action was taken.

Whenever an application for exemption is presented to the Board of Supervisors, as provided in this section, a stay of enforcement of the penal provisions of this ordinance is hereby granted the applicant until the expiration of twenty (20) days from and after, but including, the day of the date the Board of Supervisors disapproves such application, in whole or in part, if an order of disapproval be entered.

(As amended by Ord. 263.)

(Sections 6, 7 and 8 of Ord. 253 repealed by Ord. No. 263.)

Section 9. Application, Permit and Bond Required—Bond Exemptions

(a) Before any person may conduct surface mining operations in said county, as herein provided, he shall make and file with the Board of Supervisors of said county an application in writing for a permit to mine, the approved form thereof to be provided by said Board, and shall then pay forthwith an application fee of $10.00 to the County Clerk of said county.

(b) The permit to issue in any such case shall be in form provided and approved by said Board, and shall be issued by the County Clerk of said county. No permit shall be issued to any person to conduct surface mining operations, as herein provided, unless and until such application is filed and such fee paid, as herein prescribed, nor until such person first files with said County Clerk a surety bond in the penal sum of not exceeding $10,000.00 for each parcel of land specified in such person's application to mine then on file, or in the penal sum computed at the rate of $300.00 for each acre in each parcel of land specified in such person's application to mine, then on file, whichever as to each parcel of land is the lesser sum, with sureties acceptable to said Board, and in completed form thereof, to be approved by said Board, conditioned for the faithful performance by the applicant of all of the provisions of this ordinance, on his part to be kept and performed. In lieu of such bond, cash may be deposited with said County Clerk, in the sum computed in the same manner as the penal sum herein prescribed is computed for a surety bond, to be retained as security to secure the faithful performance by the applicant of all of the provisions of this ordinance on his part to be kept and performed. Provided, however, that no bond, or cash deposit, shall be required when surface mining operations are conducted only on lands exempted from the requirements of Sections 2, 3 and 4 hereof by order issued pursuant to the provisions of Section 5 hereof, nor shall any lands so exempted be used in computing the amount of any bond or cash deposit required by this section.

(c) No person shall mine or conduct mining operations in said county as contemplated by this ordinance without first having obtained a permit so to do, as herein provided. Among other things, each such application shall accurately identify each parcel of land by legal description thereof upon which said mining operations are to be conducted by the applicant, and shall specify the number of acres involved in each parcel of land so described. The permit issued in each such case shall in like manner describe the land involved, as shown by the application to which it relates. Each permit to mine issued pursuant to the provisions of this ordinance shall be valid, unless sooner terminated, for continuous surface mining operations upon the lands described in said permit, commencing with the date of said permit.

(d) If any mining operations contemplated by this ordinance are intended to be conducted by any person other than the owner of the lands to be described in the application required elsewhere herein to be filed, the owner of such lands or his duly authorized attorney-in-fact in the name of his principal, shall endorse such owners approval of the application to be filed upon the face thereof. In the absence of such approval in such cases no permit shall be issued to the person applying therefor, anything herein to the contrary notwithstanding. When an attorney-in-fact endorses the application the power of attorney evidencing his authority shall be filed with the Board of Supervisors at the time the application is filed.

(e) A permit shall be issued to any person who first complies with the provisions of this ordinance on his part to be performed under this ordinance to obtain a permit; provided, however, that the provisions of paragraph (d) of this section are first complied with.

(f) When a permit to mine has been issued hereunder, it shall not be subject to amendment, except for clerical error appearing therein.

(g) Permits issued hereunder are not transferable and persons to whom such permits are issued shall not transfer nor attempt to transfer them, or any of them, to any other person or persons.

(h) No exemption under Section 5 of this ordinance shall be granted to any person who has not first applied for a permit to conduct surface mining operations under the provisions of this section.

(As amended by Ord. 263.)

Section 10. Termination of Permits

Without in any manner affecting the penal provisions of this ordinance the Board of Supervisors of said County reserve the right and power, and it may exercise such right and power, to terminate any permit to mine issued hereunder for any violation of this ordinance, after granting a hearing on the question of violation of this ordinance to the person to whom the permit was granted, such hearing to be held not sooner than ten days from the service of a notice in writing by said Board upon such person to whom the permit was issued, which notice shall state the violation claimed, and the date, time and place of such hearing. Such notice may be served by said Board by registered United States mail and in such event the date of mailing such notice shall constitute and be the date of the service thereof upon the person to whom it is directed.

Section 11. Violation of Ordinance Penalty

Any violation of any provision of this ordinance is a misdemeanor, and any persons violating this ordinance or any of its provisions, upon conviction thereof, shall be punishable by a fine not exceeding the sum of $500.00, or by imprisonment in the County Jail for not to exceed six months, or by both such fine and imprisonment. For each day that any person fails to comply with this ordinance, or any provision thereof, he shall be guilty of a separate violation hereof.

Section 12. Saving Clause Constitutionality

If any section, sub-section, paragraph, sentence, clause, phrase or word of this ordinance shall be held to be unconstitutional, or otherwise invalid for any reasons, by final judgment of any court having jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance, but such unconstitutional or invalid provision shall be deemed separable from the valid parts thereof. The Board of Supervisors of said

county hereby declare that it would have passed this ordinance and each section, sub-section, paragraph, sentence, clause, phrase or word thereof, irrespective of the fact that any one section, sub-section, paragraph, sentence, clause, phrase, or word of said ordinance may be held unconstitutional or otherwise invalid.

Merced Dredging Co. 1805 Mills Tower, San Francisco. This company is partly owned by the Natomas Co., Sacramento. Location: South of Snelling in T. 5 S., R. 14 E., M. D. The company began operating a connected-bucket dredge in 1934, which operated continuously until October 13, 1942, when it shut down as a result of War Production Board Limitation Order L-208. Operations were not resumed until July 15, 1945. After two months elapsed, an anti-dredging ordinance issued by the Merced County Board of Supervisors again halted operations on September 13, 1945. The company immediately filed an injunction against the resoiling ordinance. In 1946 a favorable ruling on the injunction was issued and the dredge started up on September 6. Operations continued until April 17, 1949, when the ground was worked out. The boat was shut down and dismantled. The wooden framework remained on the property in July 1951.

It was an electrically operated boat with a 52- by 110-foot hull and the bucketline carried 60 buckets of 10-cubic foot capacity. Daily earth-moving capacity was 9,000 cubic yards.

San Joaquin Mining Company. 1805 Mills Tower, San Francisco. This company is jointly owned by the Natomas Company, Sacramento, and the Merced Dredging Company, 1805 Mills Tower, San Francisco. Location: About 3 miles west of Snelling in T. 5 S., R. 13 E., M. D.

In 1936 the company built a large connected-bucket dredge which it began operating in the Snelling district on March 19, 1937. The dredge was electric-powered and carried a bucketline with sixty-four 10-cubic foot buckets. The boat worked continuously until October 14, 1942, when it was shut down by War Production Board Limitation Order L-208. The dredge was still on the property in December 1951.

Snelling Gold Dredging Company. Location: On the Merced River between Snelling and Merced Falls in secs. 3, 10, 11, 12, T. 5 S., R. 14 E., M. D. and secs. 4, 5, 6, 7, 8, 9, T. 5 S., R. 15 E., M. D. Officers: C. J. Thurman, president; Evan Estep, vice-president and superintendent; Ray Estep, secretary and general manager; Snelling.

The company began operating a Yuba-type connected bucket dredge in 1932. A second dredge was added in 1935 and both dredges continued to operate until 1942. The first boat ceased operating on March 31, 1942. The second boat was shut down on October 15, 1942, as a result of War Production Board Limitation Order L-208. No further dredging was done until September 8, 1946, when the first dredge resumed operations. The second dredge started production late in 1947, and continued working until October 10, 1949, when it was permanently shut down and partly dismantled. The first dredge operated from 1946 through 1951. The company estimated that their present holdings would be nearly worked out by the end of 1951.

Most of the holdings of the company consist of marshy uncultivated land in the alluvial plain of the Merced River. It is sparsely overlain by a cover of brush and trees which are removed by a Caterpillar bulldozer preparatory to dredging. The bulldozer is also used to fill in water holes after dredging and thus eliminate mosquito hazards. The gravel

is nonclay-bearing and uncemented, but often carries an overburden of sand to a depth of 3 feet. The thickness of the gravel averages 18 feet, and fragments are usually minus 12 inches in size. The bedrock consists of volcanic ash and the bedrock surface is very irregular. A 75-foot horizontal swing of the bucket ladder has shown a difference in elevation of as much as 8 feet.

The gold is distributed throughout the gravel but the principal concentration is near bedrock. Consequently it became customary for the buckets to remove about a foot of the bedrock surface. The gold varies from pin-point size to small flakes and averages 888 fine. Platinum, silver, lead shot, tramp iron, Indian artifacts, and coins are also recovered. The value of the gravel averages about 10 cents per yard; mining costs are about 6 cents per yard.

The dredge is supported by a steel hull 42 by 96 feet in size. The digging ladder carries a string of 66 closely connected buckets, each having a capacity of 7 cubic feet, and is powered by a 150-horsepower motor. Digging progresses at a uniform rate of 26 buckets per minute. The buckets discharge to a 6 by 30-foot inclined trommel of $\frac{3}{4}$-inch steel plate that is perforated by reverse taper openings $\frac{3}{8}$ to $\frac{1}{2}$ inch in size. The plus $\frac{3}{8}$-inch oversize gravel passes out the end of the trommel to the tailings stacker. The gold-bearing sand drops through the trommel and is distributed to seven transverse sluice boxes and five longitudinal sluice boxes on each side of the dredge. The sluice boxes are 35 inches wide and are equipped with rubber-lined Hungarian riffles. Quicksilver is sprinkled throughout the first 5-foot length of the sluices, and mercury traps are located at the first 10-foot points.

Cleanups are made every 10 days in a 1- by 15-foot Long Tom where three products are recovered, namely: amalgam, base (lead shot and tramp iron), and black sand (containing platinum). Three buckets containing the products are carried to the retort house in Snelling, where the marketable products are separated.

The amalgam is retorted to recover the gold and reclaim the quicksilver. The black sand is treated in a mechanical panner to recover the fine gold and platinum. The base is carefully panned by hand. The panned lead is melted and cupelled in a muffle furnace to recover the precious metals. The cupels are crushed and the contained litharge is sold to a smelter for recovery of the lead. Platinum recovered from the base and black sand is purified by acid treatment.

The dredge operates 24 hours a day as is customary with boats of this type. Mechanical efficiency is maintained at a high level, ''down time'' running about 10 percent. A crew of three men work each shift. In addition, the day shift is augmented by two bankmen and a dredgemaster.

Yuba Consolidated Goldfields. Location: About 4 miles east of Snelling. T. 5 S., R. 15 E., M. D. Officers: Stanley Bolster, president; F. C. Van Deinse, general manager, 351 California Street, San Francisco.

The company's first electrically operated dredge in this area, the Merced Unit, together with some of the ground was obtained in 1930 from La Grange Gold Dredging Company. Operations under the new company began in 1931.

Depth of the gravel deposit varied from 18 to 36 feet. The gravel was underlain by a slate bedrock in the vicinity of Merced Falls, and by

volcanic ash near the westerly part of the property. Gold and a small quantity of platinum were recovered.

The dredge was a connected-bucket type, each bucket having a 9-cubic foot capacity. There were 62 buckets in the line and the dredge had a daily capacity of 7,500 cubic yards. The company began operating a second connected-bucket dredge in the same area in 1935. The new dredge carried a line of 71 buckets, each bucket having a capacity of 5¾ cubic feet. The daily capacity of this dredge was 4,500 cubic yards. Both dredges continued to operate until 1939, employing a total of 45 men. The work of the small dredge was completed in 1939. The large dredge worked in the same locality until the end of 1941 when the ground was worked out and the dredge was removed.

Gypsum

The gypsum, ($CaSO_4 \cdot 2H_2O$), mined in the western foothills of the county is an impure variety classed as gypsite. This consists of an earthy mixture of gypsum, sand, clay, marl, or diatomaceous earth. It is an efflorescent deposit, a type often formed in regions of little rainfall and rapid evaporation. The gypsum-bearing ground water is drawn upward toward the surface by capillary action. Small crystals of gypsum, which can be seen with a hand lens, are then deposited to form the commercial deposit. Most of the deposits are close to the surface with little or no overburden, and range from 6 inches to 6 feet in thickness. They are often called "cap gypsum" by the miners. The lower contact may be sharp or merge into the underlying formations. Although samples containing 90 percent or more gypsum can be taken from a deposit, the irregularity of deposition precludes the possibility of producing a product containing over 70 percent gypsum consistently. The deposits are usually mined with power scrapers.

About 400,000 tons of gypsum is used annually in California as an agricultural mineral. This usage has been described by Rollins [24] as follows:

> "Most of the agricultural gypsum sold in California is used in San Joaquin Valley within trucking distance of local deposits, although a portion of the tonnage is used in other parts of the state. It is applied to improve soil texture, increase permeability to water, alleviate severe clod and crust formation, render the soil easier to work, and to aid in the reclamation of alkali soils. Gypsum reacts with sodium carbonate, commonly called black alkali, to form sodium sulphate, commonly called white alkali, and calcium carbonate, which is the same as limestone. Sodium sulphate is much less injurious to plant life than sodium carbonate, so the conversion is of distinct advantage. Soils alkaline with sodium carbonate are sticky when wet, and set to a hard cake when dry. Addition of gypsum aids in flocculating the mass and tends to make the soil loose and friable."

Agricultural Minerals and Fertilizer Company. Location: About 9½ miles south of Los Banos in the foothills of the Coast Ranges in NE¼ sec. 2, T. 12 S., R. 10 E., M. D. A. D. Sousa, P. O. Box 832, Los Banos, owner of the company, leases about 5,000 acres from Dr. Artigues, San Francisco.

Mining commenced at this location in 1946 and has continued intermittently to October 1951. During this time about 1,500 tons of agricultural gypsum including some agricultural lime and diatomite have been produced.

---

[24] Rollins, Robert Z., Minerals useful to California agriculture: Calif. Div. Mines Bull. 155, p. 109, 1951.

A deposit of buff-colored Tertiary marine diatomite of upper Eocene age outcrops at an elevation of about 800 feet along the crest of the front range hills in this locality. The diatomite beds strike N. 42° W. and dip 42° NE. and constitute the upper part of the Kreyenhagen formation. This formation also contains interbedded calcareous layers, clay shales, and fine sand, and attains a total thickness of about 900 feet in the area. Near the surface the diatomite is capped by an efflorescent deposit of gypsite. Silty overburden in places reaches 3 feet in thickness. A commercial deposit of gypsite 3 to 4 feet thick has been discovered as a result of drilling with a 3-inch hand sampling auger.

The gypsite is mined and stockpiled during the spring and summer months. Surface mining is progressing at two places on the hilltop. At the northerly locality a pit about 3 feet deep and 100 feet in diameter has been developed. About a quarter of a mile to the southeast, a second pit about 5 feet deep and 200 feet in diameter is exposed. The overburden is scraped off and piled to one side of the working area. The gypsite is then mined with a Be-Ge 4½-yard scraper, towed by a TD-9 International Caterpillar diesel. Very careful sampling and blending of the product at the pits is exercised by the company in order to meet its guarantee of a minimum gypsum content of 30 percent. Reports of analyses from the California Department of Agriculture show the product averages 48 percent gypsum.

Local demand governs the delivery and production schedule. Gypsite is shipped and spread during the ground conditioning season, which usually extends from November to February in the Los Banos farm area. Two 10-wheel General Motors Corporation spreader trucks are used for delivering and spreading the gypsite.

Manganese

Manganese ore in the California Coast Ranges usually occurs in chert (SiO_2) of the Franciscan formation of Upper Jurassic age. The Franciscan formation is well exposed throughout the Coast Ranges. The deposits are sedimentary and the orebodies occur parallel to the bedding, although subsequent deformation has tilted the beds from their original flat-lying position. Rhodochrosite, $MnCO_3$, is the primary mineral, and the highest grade ore has been formed by its alteration to black oxides. The largest orebodies generally consist of a core of massive high grade oxide, surrounded by a layer of disseminated ore grading into chert. One deposit of manganese in Merced County has been described by Trask.[25]

"Briggs Mine." (By Max D. Crittenden, Jr., September 26, 1942.) "The Briggs mine is just within the border of Merced County in the S½NW¼ sec. 13, T. 13 S., R. 9 E. It is reached by 30 miles of poor road, via the McCreery and Frandsen Ranches, in the old Cleveland district. The road ends 1 mile from, and about 2,000 feet below, the prospect. The property is owned by Mrs. Briggs of Hollister. Development consists of several small pits and trenches. The Briggs prospect is near the upper contact of a band of chert 100 feet thick, surrounded by sandstone. The main mass of the chert forms rugged outcrops and cliffs above the sandstone, but the chert in which the manganese is found is above the steepest part of the hill.

"The general strike of the beds in this area appears to be N. 60° E., the dip is gentle to the north. The beds are cut by several faults with moderate throws. Small folds and faults are common. The primary ore consists of manganiferous chert beds, from which extensive surface oxidation has produced small quantities of good grade oxide ore, but which contain much silica."

No production has been made from this deposit.

[25] Trask, Parker D., Geologic description of the manganese deposits of California: Calif. Div. Mines Bull. 152, p. 150, 1950.

Platinum

The platinum group includes six related heavy metals which are insoluble in most acids. In the order of common occurrence they are: platinum, iridium, osmium, palladium, rhodium, and ruthenium. The crude platinum recovered in mining operations is generally an alloy of two or more of the above metals, and may also contain additional impurities such as iron, copper, and silica. The prices quoted in trade journals for metals in this group are for the individual refined metal, consequently the price received by the miner for his product may be only a fraction of the quoted price.

Primary platinum occurs disseminated through the basic or ultrabasic igneous rocks. A belt of these rocks (including diabase, pyroxenite, peridotite, and serpentine) traverses the western part of the Sierra Nevada for a distance of 180 miles, extending from Madera County on the south to Plumas County on the north. The westward flowing rivers crossing this belt have separated the platinum from the host rock, carried it along their beds, and concentrated it in alluvial deposits when their speed has been retarded. The Merced River has in this fashion distributed platinum throughout its floodplain in the Merced Falls-Snelling area. This platinum has been subsequently recovered by the bucket-line dredges as a by-product of gold placer mining.

Although no complete record of platinum recovered in the county has been maintained, the available figures indicate a total recovery of over 2,643 ounces of crude metal valued at $92,116. The value of platinum recovered was therefore about .006 percent of the value of gold, or about $\frac{2}{3}$ ounce of platinum per 100 ounces of gold. The largest recovery of platinum was made during the period of gold dredging along the Merced River from 1932 to 1942 inclusive. Merced County was the leading platinum producer in the state during 1934, 1936, 1938, 1940, 1941, and 1942. The largest recovery was made during 1941 when a total of 482 ounces valued at $15,485 were recorded. Six bucket-line dredges were active from 1938 to 1941 and each dredge made some contribution to the total production. However, since the earthmoving capacity of each of the dredges was at least 4,500 cubic yards per day, it is obvious that the recovery of platinum alone could not form the basis of a successful mining enterprise.

Quicksilver

The presence of cinnabar, HgS, in the Stayton mining district was noted shortly after the discovery of the antimony-bearing veins. This district is located in the western part of Merced County in the SW¼ T. 11 S., R. 7 E., and in the NW¼ T. 12 S., R. 7 E., M. D. Tertiary igneous intrusive and extrusive rocks of basalt, andesite, and rhyolite, crop out throughout the area. The quicksilver deposits consist of fractured antimony-bearing quartz veins with later coatings of cinnabar, cinnabar-filled fractures in basalt, or cinnabar replacements in silica-carbonate rock. The orebodies are determined by faulting and occur where the cinnabar fillings are numerous.

There are five principal quicksilver mines in the Stayton district, three of which—Stayton, Gypsy, and Yellowjacket—are in Merced County. The Stayton and Gypsy mines have produced a total of 1,605 flasks of quicksilver valued at $133,586, about 62 percent of which was produced between 1870 and 1880. No production was recorded between 1880 and

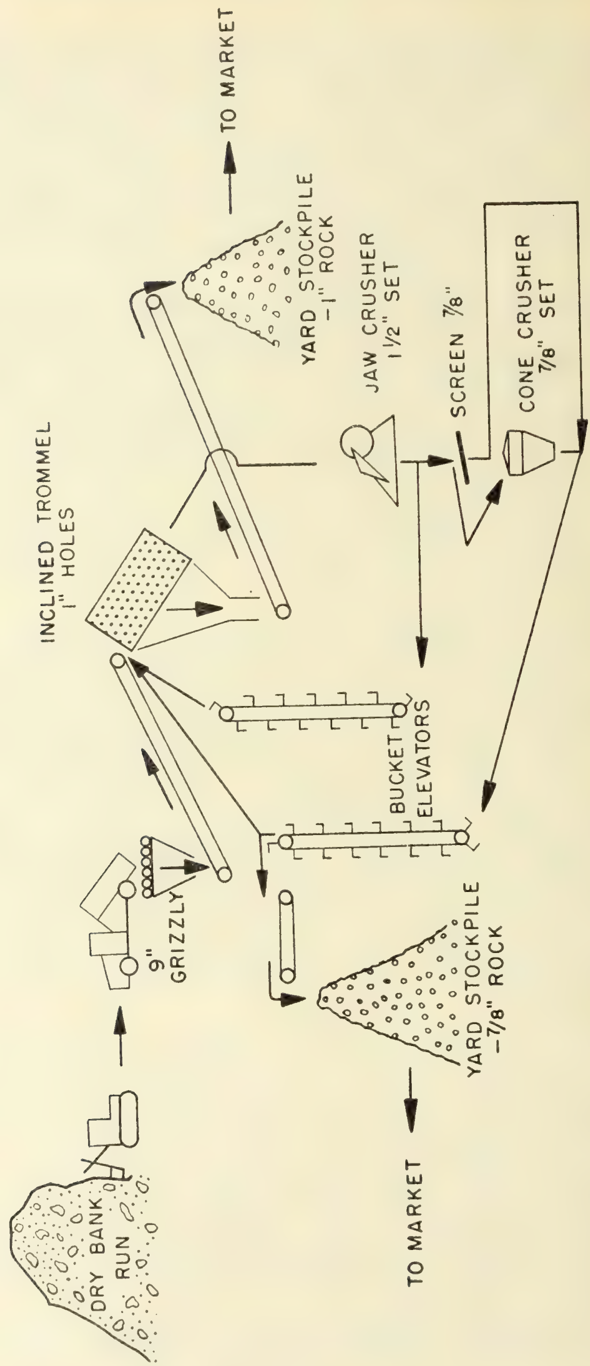


FIGURE 3. Flow sheet of sand and gravel operation modified after Richardson's sand and gravel portable plant.

1920. Bailey and Myers[26] placed estimated ore reserves for the entire district at 1,000 flasks, and stated "the chances of finding new orebodies are rather good." They described the mines as follows:

"The Stayton mine, owned by Mr. R. B. Knox, is in sec. 5, T. 12 S., R. 7 E. in western Merced County. Located in 1870, it has been the principal producer in the Stayton district. The first mining is said to have been for stibnite, but between 1876 when the Stayton Mining Company gained control of the property, and 1880, quicksilver was mined, and it is reported that about 1,000 flasks were produced from the Stayton and Gypsy mines. After the early eighties the mine was inactive, except for a short period in 1917-18, until 1920 when Mr. Knox began small-scale operations. Since 1920 the mine has yielded approximately 400 flasks of quicksilver. It is equipped with a 12-ton furnace and a retort.

"The ore is cinnabar in veinlets that fill fractures in both fresh and kaolinized basalt along a north-trending normal fault zone which has a dip of 58° W. Cinnabar extends from the footwall across the fault zone and into the hanging wall for a distance of at least 75 feet. Although "paint" can be found throughout most of this distance, the minable ore is confined to several narrow veins. Minable ore was found against the footwall, 7-12 feet west of the footwall, below a zone of clay gouge, and in small amounts along a series of parallel fractures 60 feet west of the footwall on the 30-foot level. The location of the stopes suggests that the ore was localized by slight bulges in the footwall where there are changes of a few degrees in strike.

" . . . The mine was being operated in 1941 by three men who had no difficulty in taking out and retorting enough hand-sorted ore to yield a couple of flasks of quicksilver each month. Development work has shown that ore suitable for hand-sorting to an average of 40 pounds to the ton occurs above and west of the 30-foot level. The intervening 60-foot zone, between this level and the footwall, contains many stringers and coatings of "paint" but is said to average less than 2 pounds of quicksilver to the ton. . . .

"The best area for future development lies to the west, as the zone of alteration and shearing is known to be at least 400 feet wide in the nearby Yellow Jacket mine. A large amount of additional prospecting and development work may be necessary before workable orebodies are found. . . .

"The Yellow Jacket mine, owned by Mr. R. B. Knox, is in sec. 5, T. 12 S., R. 7 E., in western Merced County. The portal is slightly more than 500 feet northwest of the portal of the Stayton mine. Only a few tons of ore have been taken from the mine. . . . Although some ore has been found in the mine no ore was in sight in 1941. The mine is apparently in a nearly barren zone and future development cannot reasonably be expected to reveal more than small, scattered orebodies."

"The Gypsy mine, owned by Mr. R. B. Knox, is in sec. 5, T. 12 S., R. 7 E., in western Merced County. It is about 2,400 feet north of the Stayton mine on the same wide fracture zone, but probably not on the continuation of the same vein. Its production record can only be inferred; perhaps less than half of the 1,000 flasks taken from the district prior to 1880 came from this mine. The mine was recently leased, and operations on a small scale were expected to begin in the summer of 1941. . . .

"The mine explored a silicified zone 10-17 feet thick along a normal fault which strikes N. 20° W. and dips 37°-51° SW. The country rock is a well-indurated tuff-breccia of the basaltic unit. . . .

"Cinnabar, the only ore mineral, occurs as light-red to deep-purple massive vein fillings in steep fractures, and as colloform coatings encrusting quartz crystals in small vugs. Light yellow-brown opal locally accompanies the cinnabar.

"The orebody, composed of numerous steep fractures filled with cinnabar, was about 50 feet long and 5-10 feet thick, and extended down the dip of the fault for 75 feet. The average tenor is believed to have been about 10 pounds of quicksilver to the ton. . . . The segment of vein between the Gypsy mine and a resistant outcrop of the vein 500 feet to the south has not been adequately prospected and is one of the most favorable places in the district for future exploration."

Sand and Gravel

Sand is unconsolidated granular material from minus ¼-inch size to plus 200-mesh, resulting from the natural disintegration of rocks. Gravel is similar material ranging from plus ¼-inch to minus 3½ inches in size.

[26] Bailey, E. H. and Myers, W. B., op. cit., 1942.

Deposits consisting solely of sand or gravel are known. Most fluvial deposits, however, are heterogeneous mixtures of these components which may also include sand-undersize (fines) and gravel-oversize (cobbles and boulders). The deposits are poorly sorted, imperfectly stratified, and elongated in the direction of stream flow. They may be replenished annually whenever the transporting power of the stream is increased by winter storms.

Sand and gravel has been an important part of the Merced County mineral production since 1910. Until 1944, the value of this production has been recorded under the heading ''Miscellaneous Stone.'' In many counties this term includes the product of crushed rock quarries as well as the product of sand and gravel deposits. No rock quarries exist in Merced County, although substantial quantities of gravel are crushed to smaller size in the process of preparing the crude material for the market.

The chief source of sand and gravel in the east side of the county has been from the channel and banks of the Merced River between Snelling and Livingston. Additional quantities of this material have been obtained from Bear Creek and Mariposa Creek. Dredge tailings in the vicinity of Snelling have been the source of some crushed rock used in county road construction. These tailings provide a substantial reserve of crushed rock for future construction projects. The gravels found in the east side streams consist chiefly of fragments of the more resistant igneous and metamorphic rocks occurring in the Sierra Nevada. They include quartz, quartzite, gneiss, granitic rocks of many types, and extrusive igneous rocks such as rhyolite and andesite.

Los Banos Creek, an intermittent stream, is the locus of most of the sand and gravel plants on the west side of the county. The rock content is essentially andesite, basalt, rhyolite, sandstone, and quartz. The excavation of the Delta-Mendota Canal near the base of the western foothills was accompanied by the ''piling up'' of extensive banks throughout that part of the county. Much of the material in these banks is gravel which is now screened and used locally for road surfacing.

The ''in place'' value of sand and gravel deposits is low and the market value of the products is largely dependent on the cost of preparing them for sale. Hence the deposits are mined by low-cost surface methods using equipment with a large earthmoving capacity. In Merced County mining along the flowing streams is done either with dragline excavators or with slackline cableway excavators, both of which function under water. Mining in the dry pits along the intermittent streams is done with power shovels or dragline excavators.

The dragline is a mobile unit especially adaptable to a variable deposit. Here, frequent changes in digging location may be required to produce the gravel sizes desired. The dragline loads to trucks for transport to the plant. Hence, the excavation and plant sites may be located at a considerable distance from each other. The slackline cableway has greater horizontal and vertical digging range, but is less mobile than the dragline. It is usually supported by a gin pole, 75 feet or more in height, and is set up to dig and deliver gravel to a receiving bin or surge pile adjacent to the processing plant. Thus it also acts as a transporting unit. The power shovel is a mobile unit which digs faster than either the dragline or slackline cableway, but is suitable only to dry pits or banks.

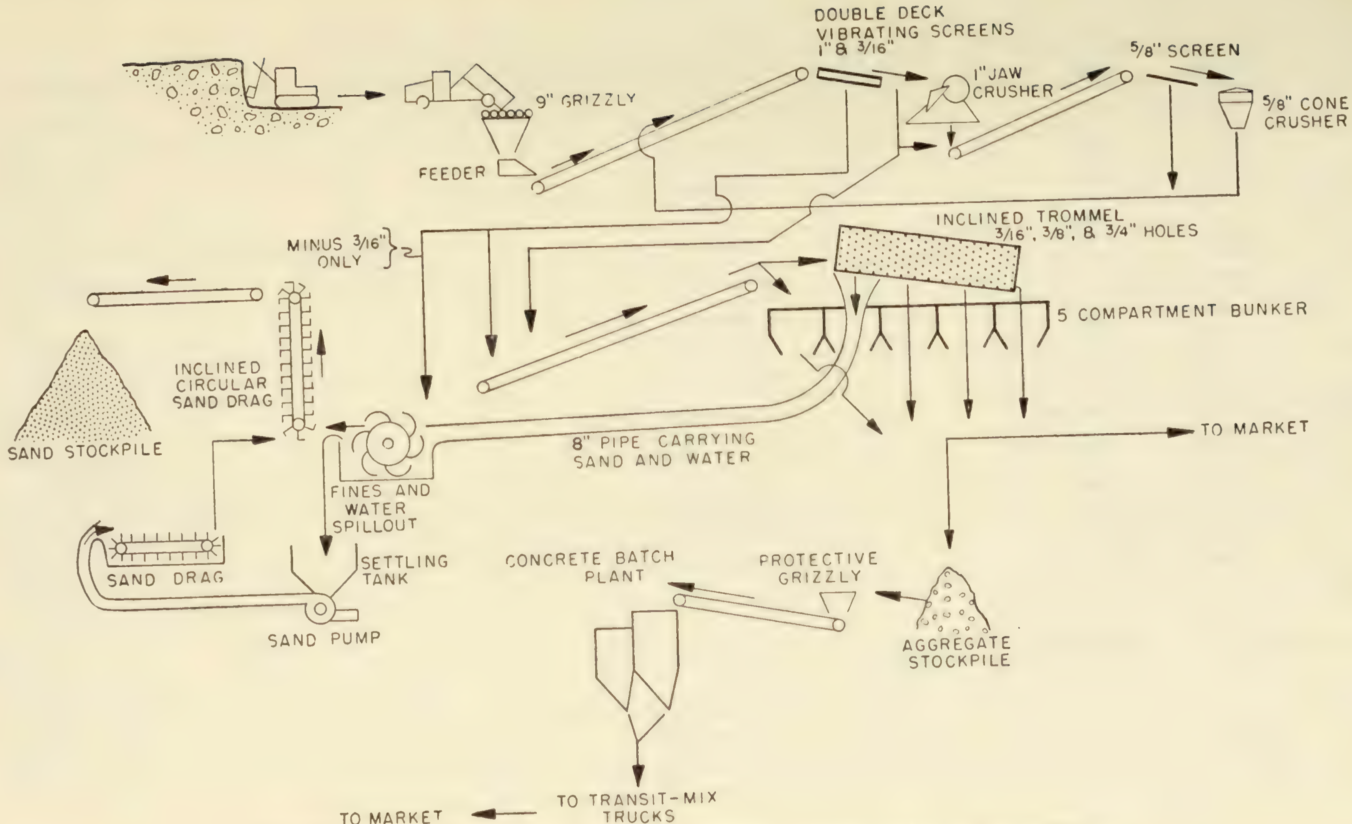


Figure 4. Flow sheet of sand and gravel operation modified after Los Banos Gravel Company.

Table 2. Sand and gravel data sheet.

GENERAL

Map No.	Name	Location				Started operating	Status 12/1/51
		T.	R.	Sec.			
10	Bliss, R. O.	9	15	15	Old Creek, Athlone	9/ 1/50	Idle
11	Cressey Sand and Gravel	6	12	9	Merced River, Cressey	1948 (?)	Active
12	Los Banos Gravel Co.	10	10	32	Los Banos Creek	1941	Active
13	Merced County	7	15	16	Bear Creek, Tuttle	1946	Active
14	Merced County	10	10	32	Los Banos Creek	pre-1927 (?)	Intermittent-contracted
15	Morrison-Knudson Co., Inc. and M. H. Hassler Const. Co.	10	10	32	Los Banos Creek	1950	Idle
16 17	Richardson Sand and Gravel No. 1 No. 2	8 10	8 10	15 32	Garzas Creek, Los Banos Creek	1951 1951	Idle Active
18	River Rock, Inc. No. 1	5	13	26	Merced River	10/ 1/46	Active
19	River Rock, Inc. No. 2 (Merced Sand and Gravel Co.)	5	12	35	Merced River	1950 (1944)	Active
20	Silva, M. F.	6	12	3	Merced River	1950	Idle
21	Skov & Wychophen	6	12	7	Merced River, Cressey	1951	Active
22	Turlock Rock Co.	6	12	8	Merced River, Cressey	1948	Active
23	Wood, C. C.	10	10	32	Los Banos	1951	Active

Table 2. Sand and gravel data sheet—Continued.

	GEOLOGIC				MINING	
Map No.	Name	Type of deposit	Rock types	Size of deposit	Equipment used	Type of excavation
10	Bliss, R. O.	Dry creek	Silica sand	Large	Dragline excavator	Dry pit
11	Cressey Sand and Gravel	River bar	Sand	Small	Dredge, 4-in. suction pump	Submarine
12	Los Banos Gravel Co.	Dry creek	Extrusive igneous	Moderate	Power shovel	Bank
13	Merced County	Creek bed	Igneous, metamorphic	Small	Dragline excavator	Pit
14	Merced County	Dry creek	Extrusive igneous	Small	Dragline, slackline cableway	Pit
15	Morrison-Knudson Co., Inc. and M. H. Hassler Const. Co.	Dry creek	Extrusive igneous	Large	Power shovels	Pit
16 17	Richardson Sand and Gravel	Canal excavation bank; dry creek	Extrusive igneous, sedimentary	Small	Power shovel or bulldozer	Bank, Pit
18	River Rock, Inc. No. 1	River bed	Igneous and metamorphic	Large	Dragline excavator	Pit
19	River Rock, Inc. No. 2 (Merced Sand and Gravel Co.)	River bed	Igneous and metamorphic	Large	Dragline excavator	Pit
20	Silva, M. F.	River terrace	Igneous and metamorphic	Moderate	Slackline cableway	Pit
21	Skov & Wychophen	River bed	Igneous and metamorphic	Large	Slackline cableway	Pit
22	Turlock Rock Co.	River bed	Igneous and metamorphic	Large	Slackline cableway	Pit
23	Wood, C. C.	Canal excavation bank	Miscellaneous	Moderate	Dragline excavator	Bank

Table 2. Sand and gravel data sheet—Continued.

MINING						PROCESSING PLANT	
Map No.	Name	Excavation size			Transport distance	Crushing	Classification
		Width	Length	Depth			
10	Bliss, R. O.	150 ft.	¼ mi.	5-20 ft.	5 mi.±	None	None
11	Cressey Sand and Gravel	-----	----	50 ft.	300 ft.	None	Screen ⅛ in., settling basins, drag classifier, bins
12	Los Banos Gravel Co.	-----	----	20 ft.	200 yds.	Primary jaw secondary cone	Trommel with scrubber, vibrating screens, circular sand drag.
13	Merced County	-----	----	25 ft.	¼ mi.	Pioneer portable	Pioneer portable.
14	Merced County	-----	----	5-20 ft.	200 yds.	Jaw	Inclined trommel, crusher, elevator circuit.
15	Morrison-Knudson Co., Inc. and M. H. Hassler Const. Co.	150 ft.	¼ mi.	10-30 ft.	300 yds.	Primary cone; rod mill for fines	Vibrating screens with spray, circular sand wheels.
16 17	Richardson Sand and Gravel	-----	----	10-20 ft.	100 yds.	Primary jaw, secondary cone	Combination portable plant with trommel and elevators.
18	River Rock, Inc. No. 1	-----	----	30 ft.	1 mi.±	Primary jaw, secondary and tertiary cones	Dual vibrating screen towers with spray, sand drag, dust return.
19	River Rock, Inc. No. 2 (Merced Sand and Gravel Co.)	-----	----	30 ft.	¼ mi.	Jaw and rolls	Portable Austin-Western No. 100 (dry), and sand drag
20	Silva, M. F.	-----	----	1-10 ft.	100 yds.	Jaw	Vibrating screen with spray, screw conveyors, radiating conveyor belts.
21	Skov & Wychophen	-----	----	30 ft.	100 yds.	Jaw	Vibrating screens with spray, crusher, elevator circuit; sand drag.
22	Turlock Rock Co.	-----	----	30 ft.	100 yds.	Jaw	Vibrating screens with spray, crusher, return belt circuit; sand drag.
23	Wood, C. C.	30 ft.	----	1-15 ft.	--	None	Portable screen to trucks, dry.

Table 2. Sand and gravel data sheet—Continued.

PROCESSING PLANT

Map No.	Name	Products	Rated capacity	Number of employees	Remarks
10	Bliss, R. O.	Sand.	--	2	Base for freeway.
11	Cressey Sand and Gravel	Plaster sand.	10 yds. per hr.	2	Screen oversize used for fill rock.
12	Los Banos Gravel Co.	Concrete aggregate and sand.	800 tons per day.	10	Concrete batch plant; well water.
13	Merced County	Asphalt road aggregate.	--	6	Surface county roads.
14	Merced County	Road rock.	--	3	Plant inactive since 1949.
15	Morrison-Knudson Co., Inc. and M. H. Hassler Const. Co.	Concrete aggregate, sand, and fines.	1,000 tons per hr. (?).	10 to 15 per shift.(?).	Delta-Mendota Canal construction; well water.
16 17	Richardson Sand and Gravel	Minus 1-inch road rock.	300-600 tons per day.	5	Mobile, gasoline power.
18	River Rock, Inc. No. 1	Concrete aggregate and sand.	600-1,000 yds. per day.	10 to 15	Largest active plant in county.
19	River Rock, Inc. No. 2 (Merced Sand and Gravel Co.)	Unwashed—1½+5/16, washed—5/16 (sand).	1,000 yds. per day.	8	Diesel power.
20	Silva, M. F.	Concrete aggregate (?).	?	?	Small production made.
21	Skov & Wychophen	Concrete aggregate and sand.	300 yds. per day.	4	Formerly on Tuolumne River.
22	Turlock Rock Co.	Concrete aggregate and sand.	400 yds. per day.	3	Subsidiary of Turlock Concrete Pipe Co.
23	Wood, C. C.	Minus 4-inch canal-road rock.	?	5	Mobile unit.

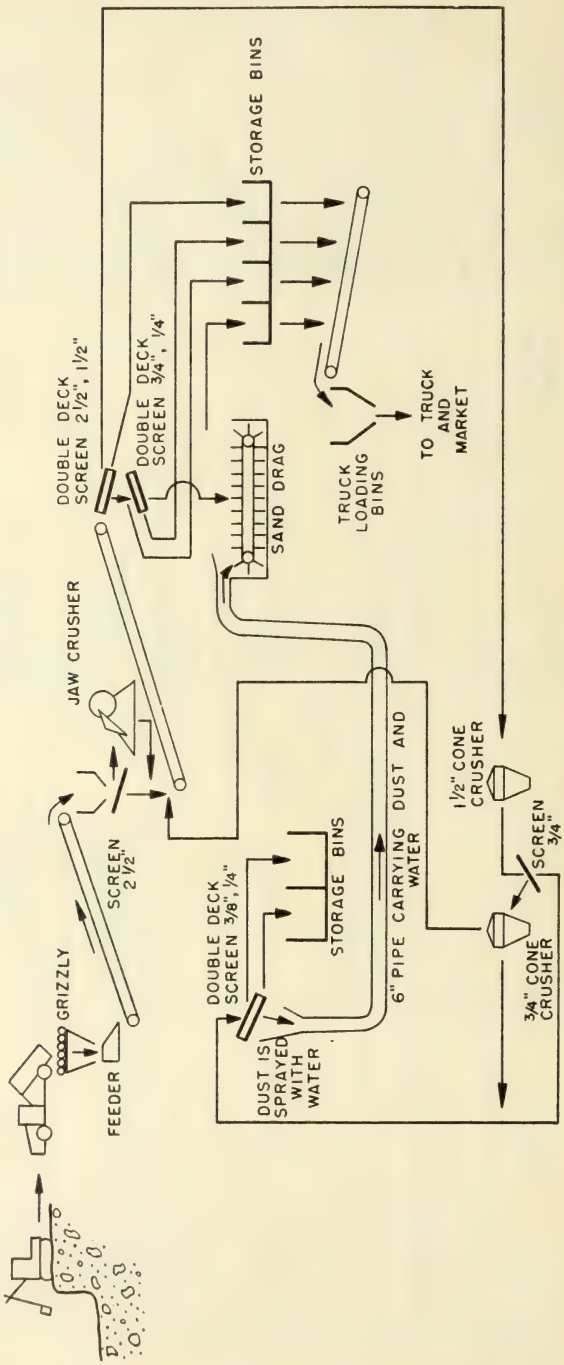


FIGURE 5. Flow sheet of sand and gravel operation. Modified after River Rock, Inc., Number 1.

The pit-run material is usually transported a short distance to the processing plant where it is washed, screened, crushed, and recirculated, depending on the number and kind of products desired. The operations in this county range from highly mobile, portable plants preparing a limited number of unwashed products, to complex plants preparing washed products to meet construction specifications. On the west side of the county, wash water is obtained from wells drilled to a depth of 60 feet. The principal use of the highly processed gravel is in concrete aggregate. Here, the size range varies from plus $\frac{1}{4}$ inch to minus $1\frac{1}{2}$ inches. Sand specifications are somewhat dependent on designing experience, but some typical examples follow: concrete sand, 100 percent minus $\frac{3}{8}$ inch, 85 percent minus 4 mesh, 50 percent minus 50 mesh; building sand, 50-90 percent plus 50 mesh; plaster sand, 80 percent plus 8 mesh.

FIGURE 6. Sand and gravel plant of Hassler Construction Company. The plant processed gravel from Los Banos Creek for use in construction of Delta-Mendota Canal.

Many fluviatile deposits are deficient in the fine sand necessary in concrete mixes for road and building construction. Special methods are therefore necessary to produce fine sand in large quantities from the material at hand. A method used by the M-K Hassler Construction Company and other large sand and gravel plants was described by the author in an earlier publication.[27] Briefly, the method involves the use of a Marcy rod mill to grind $\frac{3}{8}$-inch gravel to smaller sizes. The mill is fed at both ends and the sand is discharged through peripheral ports in the center of the shell. Maximum feed load of 51 tons per hour resulted in a product 78 percent minus 4 mesh, 23 percent minus 16 mesh, and 8 percent minus 50 mesh. A minimum feed load of 20 tons per hour resulted in a product 100 percent minus 4 mesh, 76 percent minus 16 mesh, and 24 percent minus 50 mesh.

[27] Davis, Fenelon F., Mines and mineral resources of Alameda County: California Jour. Mines and Geology, vol. 46, no. 2, p. 331, April 1950.

FIGURE 7. Dragline-excavator preparing trench of Delta-Mendota Canal. Bank material is now used as source of road rock for maintenance of Canal roads.

Table 2 presents the geologic, mining and processing information on Merced County sand and gravel operations in condensed form. Modified flow sheets of typical operations are shown in figures 1, 2, and 3.

Mineral Fuels

Petroleum. As far back as 1891 it was discovered that the west side of the southern San Joaquin Valley and the adjoining foothills were the loci of potential oil fields. Petroleum-producing localities were subsequently developed in this geomorphic region of Kern, Kings, and Fresno Counties. The location of these oil fields was determined by moderate folding in the Tertiary and Cretaceous rocks, which proved to be both the source and the reservoirs of the oil. The success of these discoveries encouraged producers to venture farther northward in search of new fields along the border of the northern San Joaquin Valley in Merced and neighboring counties. This search received added impetus from the apparent similarity of the foothill belt in the two areas. The oil possibilities along the west side of Merced County were discussed by Anderson and Pack [28] who stated:

"Northward from the Vallecitos and Ciervo areas the first and only definite evidence of oil in the region mapped is in the Tesla district, in the north end of the region. The structure in this district is not strictly comparable with that along the flank of the range to the south, so that different factors enter into the problem, but it is noteworthy that the first true anticline of any considerable size north of the Ciervo region is in the one occurring here.

"The eastern flank of the Diablo Range from Panoche Creek northward presents very little diversity of structure. With the exception of the folds and faults associated with the Panoche Hills and Panoche Valley, of a local anticline in the foothills near Salado Creek, and of some minor complexities in the area just south of Corral Hollow, the structure throughout the territory is that of a continuous monocline of Franciscan,

[28] Anderson, Robert and Pack, R. W., Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga: U. S. Geol. Survey Bull. 603, pp. 114, 119, 121, 182, 1915.

Chico, and Tertiary rocks dipping toward the San Joaquin Valley. This is the same as the structure discussed above in connection with the foothills north of the Coalinga district. In addition to having this unfavorable structure the unlikely aspect of this area as regards any possibilities of yielding oil is emphasized by its distance from territory in which petroleum has been found in commercial quantity and especially by the entire lack of any definite indications of the presence or even former presence of oil. The Moreno formation, which has so intimate a relation to the occurrence of oil in the Eastside field and the Vallecitos district, is traceable practically the whole way along the outer border of the hills to the north. The Kreyenhagen shale is also present in a part of the region, but neither of these formations gives evidence in this area of containing petroleum. It seems probable, therefore, that oil is not present, for if it did occur in them or in their associated beds in any appreciable amount it would be strange indeed if oil did not show itself at the outcrop at some point in this extensive region. Between Salado and Garzas Creeks, north of Pacheco Pass, the regular monoclinal structure is somewhat modified and the possibility of oil having collected is not so remote as in other parts of the region.

"It remains to consider why the extensive monocline bordering the San Joaquin Valley north of the Coalinga district and extending as far as the northern edge of the region here mapped lacks indications of oil and with the possible exception of a small area near Orestimba Creek is believed to be barren. The lower of the two shale zones that are probably the original sources of the petroleum continues along this monocline, and the upper one is present through much of the distance. There appears to be no reason to doubt that oil might have been formed in this northern region quite as well as in the region of folds to the south. Indeed, in the opinion of the writers it is highly probable that oil did exist in this northern region at one time. But in only a single small area in this region is the structure of the kind that would enable oil to be caught in pockets or that would make local areas points of concentration for oil from a large territory roundabout. Throughout this monocline the beds formerly rose a much greater distance over the older strata and in places arched over anticlinal folds farther back toward the west. This extension has been eroded away, leaving only the roots of the beds, as it were. This is true of the beds between the Coalinga field and Cantua Creek, of the Ciervo anticline, and doubtless to a great extent of the Panoche Hills dome. It is highly probable that the oil supposed once to have been in these beds has been lost through the erosion of their higher portions.

"Where Los Banos Creek cuts through the low ridge about 2 miles east of the Miguel School the Cretaceous strata in a roughly circular area about 2 miles in diameter have been flexed into an irregular fold. South of Los Banos Creek the beds strike about N. 30° W. and have an average dip of about 45°, but immediately north of that creek they bend sharply to an east or even slightly northeast strike and have a low dip, in places less than 15°. They hold this attitude for about a mile and then reassume their normal northwest strike with a dip of 40°-50°. This fold might be compared to an imperfect dome. The presence of such a fold in the otherwise normally eastward-dipping beds makes it seem natural to assume that it is the expression of local forces. About 6 or 8 miles to the north are two small areas of igneous rock, the remnants of lava which issued from different vents in the vicinity. The possibility that the fold on Los Banos Creek was caused by another intrusion which was similar to those farther north but did not reach the surface is strongly suggested. In this connection it is interesting to note that the line connecting the centers of the two areas of igneous rock near the mouth of Pacheco Pass when projected southward passes through the center of the fold on Los Banos Creek."

It is apparent from the above discussion that the surface indications so numerous in the southern part of the valley are lacking in Merced County. In addition, the foothills in this county are devoid of the folds or structural traps necessary for the accumulation of oil in commercial quantities.

Structural or stratigraphic traps which present no surface evidence of their existence may be buried far beneath the alluvium of the valley floor. They are likely to be found only by geophysical prospecting on an extensive scale, followed by the drilling of exploratory wells in the most favorable localities. A record of the 28 unproductive exploratory or wildcat wells thus far drilled in Merced County is presented in table 3.

Table 3. Holes drilled for petroleum in Merced County, to January 1, 1952.

Map no.	Location *			Company and well	Year comp. or aband.	Depth	Geology at bottom of hole
	T.	R.	Sec.				
24	5S	11E	14	Farmer, Dr. C. W. (1) Independent Exploration Co. (2) Chance 1	1948	2,294	Eocene (?)
25	5S	11E	23	Ohio Oil Co. Evans & Cook 1	12-4-50	6,552	Top Kreyenhagen 2450, top Eocene ss 2615, top Cretaceous 3850, top granite 6505
26	5S	13E	11	Great Valley Development Co. Thomsen 1	1948	1,800	
27	6S	9E	14	Turlock Oil & Gas Co. No. 1-A	pre-1925	3,152	Kreyenhagen
28	6S	10E	24	Cornell, Cox, & Meirdiercks. No. 3	1931	1,159	
29	6S	10E	24	Delhi Oil Assoc. No. 2	1931	4,620	Hard ss.
30	6S	11E	18	Tide Water Assoc. Oil Co. Turlock Land Co. 37	1942	6,505	Cretaceous
31	6S	11E	19	Delhi Oil Assoc. No. 1	1931	1,180	
32	6S	11E	28	Starlyn Oil Co. Ben Bartlett 1	10-1951	3,336	
33	7S	16E	22	Fantz, E. R. (att'y-in-fact). Cunningham 1			
34	8S	8E	36	Tide Water Assoc. Oil Co. Soares 31	1945	5,509	Cretaceous
35	8S	11E	6	Seaboard Oil Co. Seaboard Assoc. Un. How. 1	1939	7,074	Cretaceous
36	9S	9E	31	Kuns, Henry L.	pre-1925	200	Pleistocene (?)
37	9S	11E	3	Shell Oil Co., Inc. Wolfsen 61-3	1944	4,484	Eocene
38	9S	17E	4	Le Grande Syn. No. 1	1932	3,605	

39	10S	9E	8	Murrell, T. R. No. 1	1937	1,200	Cretaceous (?)
40	10S	11E	11	Shell Oil Co., Inc. Alberti 75-11	1943	4,305	Eocene (?)
41	10S	11E	19	Amerada Petroleum Corp. Cavano 1	1938	8,385	Cretaceous
42	10S	12E	29	Tide Water Assoc. Oil Co. Azevedo 48-29	1948	5,544	Cretaceous
43	10S	13E	28	Pure Oil Co. I. Gamboni et al.	1943	6,425	Cretaceous
44	11S	10E	28	International Expl. Co. Esther 1	9-10-50	1,849	Kreyenhagen (?) 1460, Moreno 1462-1847
45	12S	9E	5	Kuns, Henry L. No. 2	1930	850	Cretaceous
46	12S	9E	8	Kuns, Henry L. No. 3	1930	550	Cretaceous
47	12S	9E	9	Kuns, Henry L. No. 1	1930	1,200	Cretaceous
48	12S	11E	1	San Joaquin Oil Co. No. 1	1936	5,024	Cretaceous
49	12S	11E	1	Obispo Oil Co. and Brookshire Oil Co. Stone 1	1944	5,090	Eocene
50	12S	11E	8	Stone, Elmer B. No. 1	1939	1,981	Eocene
51	12S	11E	12	Milham Exploration Co. Ora Loma 1	1935	5,802	Eocene

* Mt. Diablo Base and Meridian.

MINERAL PROCESSING

Baroid Sales Division, National Lead Company. Location: About 1½ miles north of Highway 99 on the Snelling road, in sec. 12, T. 7 S., R. 13 E., M. D. Leslie Burch, plant superintendent; Eugene Johnson, foreman.

In 1946 the company obtained the warehouse and bunker facilities of the old Yosemite Portland Cement Company at the above location. Crude barite from El Portal, Mariposa County, and from Battle Mountain, Nevada, is shipped to the plant in bottom discharge railroad cars. The barite is crushed to minus 3-inch size at the mines. On arrival at the plant the crude is dumped to a receiving bin underlying the tracks, transported laterally on a short conveyor belt, and delivered to a 100-foot vertical bucket elevator which discharges to a bank of four concrete storage bunkers of 900 tons capacity each. From these bunkers the crude barite is drawn by gravity to conveyor belts feeding one of two Raymond roller mills. Here, the barite is reduced to 97 percent minus 300 mesh. It is sacked in paper bags and delivered by truck and rail to distributors throughout California. It is used as a weighting material in oil well drilling mud. Five men are employed at the plant.

BIBLIOGRAPHY

———— California new portland cement plant completed and now in operation: Pit and Quarry, vol. 14, no. 9, pp. 37-44, 1927.

Allen, V. T., The Ione formation of California: Univ. Calif. Dept. Geol. Sci. Bull., vol. 18, p. 361, 1929.

Anderson, Robert, and Pack, R. W., Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, California: U. S. Geol. Survey Bull. 603, 1915.

Aubury, L. E., The copper resources of California: Calif. Min. Bur. Bull. 50, p. 171, 1908.

Aubury, L. E., The structural and industrial minerals of California: California Min. Bur. Bull. 38, pp. 250, 335, 1906.

Averill, Charles V., Placer mining for gold in California: California Div. Mines Bull. 135, p. 262, 1946.

Bailey, E. H. and Myers, W. B., Quicksilver and antimony deposits of the Stayton district, California: U. S. Geol. Survey Bull. 931-Q, 1942.

Boalich, E. S., Merced County: California Min. Bur. Rept. 17, p. 148, 1920.

Bradley, W. W., Magnesite in California: California Div. Mines Bull. 79, pp. 49-50, 1925.

Bradley, W. W., and others, Manganese and chromium in California: California Min. Bur. Bull. 76, 248 pp., 1918 (Part I, manganese, Merced County).

Bradley, W. W., Quicksilver resources of California: California Min. Bur. Bull. 78, p. 72; see also San Benito County, p. 93—1918.

Briggs, Louis I. Jr., Geology of the Ortigalita Peak quadrangle, California: unpublished thesis, Univ. California.

Davis, F. F., Mineral resources of the counties of California—Merced County: California Div. Mines Bull. 142, pp. 72-74, 1949.

Davis, F. F., Mines and mineral resources of Alameda County: California Jour. Mines and Geol., p. 331, April, 1950.

Doolittle, J. E., Gold dredging in California: California Min. Bur. Bull. 36, 1905.

Haley, Charles Scott, Gold placers of California: California Min. Bur. Bull. 92, pp. 150-151, 1923.

Hess, F. L., A reconnaissance of the gypsum deposits of California: U. S. Geol. Survey Bull. 413, 1910.

Ireland, Wm. Jr., Merced County: California Min. Bur. Rept. 8, p. 350, 1888.

Jenkins, Olaf P., Copper in California: California Div. Mines Bull. 144, p. 272, 1948.

Jenkins, Olaf P., Geologic map of California, scale 1:500,000: California Div. Mines, 1938.

Jenkins, Olaf P. and others, Minerals useful to California agriculture: California Div. Mines Bull. 155, 1951.

Jenkins, Olaf P., Salient events in California and their relationship to mineral deposition: California Div. Mines Bull. 118, pp. 89-93, 1943.

Jenkins, Olaf P., Stratigraphic significance of the Kreyenhagen shale of California: California Div. Mines Rept. 37, 1931.

Kemp, J. F., The geological relations and distribution of platinum and associated metals: U. S. Geol. Survey Bull. 193, 1902.

Kilkenny, J. D., Am. Assoc. Petroleum Geologists Bull., vol. 35, no. 2, pp. 215-218, Feb. 1951.

Laizure, C. McK, Merced County: California Div. Mines Rept. 31, p. 46, 1935.

Laizure, C. McK, Merced County: California Div. Mines Rept. 21, pp. 173-183, 1925.

Leith, Carlton J., Geology of the Quien Sabe Quadrangle, California: California Div. Mines Bull. 147, 1949.

Logan, C. A., Platinum and allied metals in California: California Min. Bur. Bull. 85, pp. 33-34, 1918.

Lowell, F. L., Merced County: California Min. Bur. Rept. 14, p. 605, 1914.

May, J. C. and Hewitt, R. L., The basement complex in well samples from the Sacramento and San Joaquin Valleys, California: California Jour. Mines and Geology, vol. 44, pp. 129-158, 1948.

Minerals Yearbook: U. S. Bur. Mines, 1925 to 1949.

Murdoch, J. and Webb, R. W., Minerals of California: California Div. Mines Bull. 136, 1948.

Oakeshott, G. B., Diatomite: California Div. Mines Bull. 156, pp. 150-155, 1950.

Pabst, A., Minerals of California: California Div. Mines Bull. 113, 1938.

Payne, M. B., Type Moreno formation and overlying Eocene strata on the west side of the San Joaquin Valley, Fresno and Merced Counties, California: California Div. Mines Special Rept. 9, 1951.

Piper, A. M. and others, Geology and ground-water hydrology of the Mokelumne area, California: U. S. Geol. Survey Water-Supply Paper 780, 1939.

Ransome, A. L. and Kellogg, J. L., Quicksilver resources of California: California Div. Mines Rept. 35, p. 402, 1939.

Smith, J. P., The geologic formations of California: California Div. Mines Bull. 72, 1916.

Stewart, Ralph and others, Tertiary and late Upper Cretaceous stratigraphy of the west border of San Joaquin Valley north of Panoche Creek, Fresno, Merced, and Stanislaus Counties, California: U. S. Geol. Survey, Oil & Gas Invest. Prelim. Chart 6, 1944.

Taliaferro, N. L., Geologic history and structure of the central Coast Ranges of California: California Div. Mines Bull. 118, pp. 119-163, 1943.

Trask, Parker D. and others, Manganese deposits of California: California Div. Mines Bull. 152, p. 150, 1950.

Turner, H. W., Rocks of the Sierra Nevada: U. S. Geol. Survey, Fourteenth Ann. Rept., Pt. II, p. 465, 1894.

Turner, H. W. and Ransome, F. L., U. S. Geol. Survey, Geol. Atlas, Sonora Folio (no. 41), 1897.

Vander Leck, Lawrence, Petroleum resources of California: California Min. Bur. Bull. 89, p. 162, 1921.

Watts, W. L., Merced County: California Min. Bur. Rept. 11, p. 257, 1892.

Watts, W. L., Merced County: California Min. Bur. Rept. 10, pp. 323-331, 1890.

Winston, W. B. and Janin, Charles, Gold dredging in California: California Min. Bur. Bull. 57, pp. 211-213, 1910.

Woods, K. B. and others, Symposium on mineral aggregates: Amer. Soc. Test. Materials, Sp. Tec. Pub. 83, 1948.

TABULATED LIST OF MERCED COUNTY MINERAL DEPOSITS

The list of mineral deposits is arranged alphabetically by the name of the deposit. The mineral commodity produced is indicated in the column headed "Remarks." A separate list of holes drilled for petroleum will be found in table 3. The number following the colon in bibliographic abbreviations listed under "Remarks" is the page number. The complete reference will be found in the accompanying bibliography.

Merced County mineral deposits.

Map no.	Claim, mine, or group	Owner	Location				Remarks*
			Sec.	T.	R.	B&M	
3 and 6	Agricultural Minerals and Fertilizer Co.	Achille L. Artigues and Ancore E. Durand, San Francisco; leased to A. D. Sousa, Box 832, Los Banos.	NE¼ 2	12S	10E	MD	Diatomite[3], gypsite[6]. Extensive diatomite outcrop capped by efflorescent deposit of gypsite. (Herein; R 21: 181; R 17: 149; U. S. G. S. B 603: 211)
	Asbestos			7S 8S	16E	MD	Occurence near Mariposa Co. (R 10: 331)
	Bear Creek Sand and Gravel Co.	J. W. Huffman, 921 21st St., Merced	NW¼ 19	7S	15E	MD	Sand and gravel. Worked 1931 to 1933 and 1938 to 1945.
	Bent Bros., Inc.	G. A. Robinson, 303 E. 20th St., Merced.	S½ 24	5S	13E	MD	Sand and gravel. Provided aggregate for Exchequer Dam. (R 21: 182)
	Berg		appx.	8S	17E	MD	Copper. Possibly in Mariposa County. (R 21: 179; R 17: 149; B 144: 272)
10	Bliss Ranch	Richard O. Bliss, 906 Kohl Bldg., San Francisco.	15	9S	15E	MD	Sand. Sand for road base on Highway 99. (Herein)
1	Blue Wing	R. B. Knox, Hollister.	SE¼ 5	12S	7E	MD	Antimony. Quartz-stibnite veins in basalt. Small production of hand-sorted ore. (Herein; R 21: 175; R 12: 23; R 10: 515; R 8: 485; U. S. G. S. B 931Q: 51)
	Bottoms, R. H.		appx.	5S	15E	MD	Gold. Operated dragline dredge near Snelling in 1940. (B 135: 262)
	Briggs	Louis A. Frandsen, c/o Ellen F. Wormley, 392 Hope St., Mountain View.	NW¼ 13	13S	9E	MD	Manganese. Small quantities of oxide ore in manganiferous chert beds. (Herein; B 152: 150; R 21: 181; R 17: 150; R 14: 606; B 76: 49)
	B and W Mining Co.		appx.	5S	15E	MD	Gold. Operated dragline dredge 1 mile west of Merced Falls in 1939. (USBM MY 1939)

2	California Pottery Co.		29	7S	14E	MD	Clay. Valley silt, blended with Calaveras Co. clay, and used in manufacture of brick and building tile between 1922 and 1929. (Herein; B 99: 128; R 21: 176; R 18: 8, 102)
	Cincinnati						See Gypsy
	Coal			4S	14E	MD	Coal. In well 3 miles northwest of Snelling. (R 21: 179; R 17: 149; R 12: 58.) Also crops out in foothills between Bear Creek and Merced River (R 10: 331)
	Craycroft-Herald Brick Co., Box 814, Fresno	Craycroft Brick Co., Box 814, Fresno.	6 mi. S.	of Merced			Clay. Mined clay for use in Fresno brick plant. (B 99: 128)
11	Cressey Sand and Gravel	Vernon E. and Alma M. Lustre; Rt. 2, Box 360, Merced.	9	6S	12E		Sand. Mined from Merced River with suction dredge and used for plaster mixes. (Herein)
	Dickenson Quarry			9S	16E	MD	Sandstone (?) (B 38: 131)
	Gas						Gas. 6 miles southwest Merced; depth 600 ft. (R 10: 331)
7	Gypsy (Cincinnati, Woody)	R. B. Knox, Hollister	NE¼ 5	12S	7E	MD	Quicksilver. Cinnabar filling of steep fractures in silicified zone. Country rock is indurated tuff-breccia. (R 15: 670; R 10: 515; R 8: 350; U. S. G. S. B. 931Q: 54)
	Iron						Iron. Claim located 25 miles southwest of Los Banos in 1888. (R 10: 331)
	Johnny Green		appx.	8S	16E	MD	Copper. Topographic evidence suggests claim is in Mariposa County. (R 21: 179; R 17: 149; B 144: 272)
	Jose		4	13S	9E	MD	Copper. Considerable development work; chalcopyrite. (R21: 179; R 17: 149; R 14: 605; B 144: 272; B 50: 171)
	Kelsey	Kelsey Estate, Ltd., 2115 Canada Blvd., Glendale.	9	5S	15E	MD	Sandstone. Part of upper Ione formation quarried for local use. (R 11: 257)
	Kroh		appx.	8S	16E	MD	Copper. Topographic evidence suggests claim is in Mariposa Co. (R 21: 179; R 17: 149; B 144: 272)
	La Grange Gold Dredging Co.						See Yuba Consolidated Gold Fields.

Merced County mineral deposits—continued.

Map no.	Claim, mine, or group	Owner	Location				Remarks*
			Sec.	T.	R.	B&M	
12	Los Banos Gravel Co.	Loomis Bros; leased to A. S. Serpa and Frank Buffuna, Jr., Los Banos.	NE¼ 32	10S	10E	MD	Sand and gravel. New, small plant. (Herein)
	Magnesite						Magnesite. Mined in Stanislaus County and shipped from Ingomar, Merced County. (R 21: 181; B 79: 52)
	Merced Brickyards	W. H. McElroy and W. E. Landrum	1¼ mi.	w. of S.	P. depot		Clay. Pre-1920 operation (PR 7: 64; B 36: 250)
	Merced Clay Products Co., Ltd.		29	7S	14E	MD	Clay. Operated Calif. Pottery Co. plant in 1930.
13	Merced County (Bear Creek)	L. B. Hughes, Rt. 2, Box 483, Merced.	SW¼ 16	7S	15E	MD	Sand and gravel. Mined with dragline, screened, and mixed with asphalt for road surfacing. (Herein)
14	Merced County (Los Banos Creek)	Merced County, Merced	NE¼ 32	10S	10E	MD	Sand and gravel. (Herein)
	Merced County (Snelling rock crusher)	Merced County, Merced	S½ 3	5S	14E	MD	Crushed rock from dredge tailings. Idle
	Merced Dredging Co.	Merced Dredging Co., 1805 Mills Tower, San Francisco.	8	5S	14E	MD	Gold, silver, platinum. Connected bucket dredge. Dredged southwest of Snelling from 1936 to 1942. Shut down by L-208 in 1942. (Herein; R 31: 47; B 135: 262)
	Merced Sand and Gravel Co.						See River Rock, Inc., No. 2.
	Merced Sand and Gravel Aggregate Co.	C. V. Jones					Sand and gravel. Operated near Winton from 1939 to 1943.
	Mid State Equipment and Dredging Co.		2(?)	8S	16E	MD	Gold. Dragline on Mariposa Creek during part of 1947 and 1948.

15	M-K, Hassler Construction Co.	William and Carmen Affonso, Rt. 1, Box 412, Los Banos; leased to M-K, Construction Co.	SE¼ 32	10S	10E	MD	Sand and gravel. Produced gravel from Los Banos Creek for use in construction of Delta-Mendota Canal. (Herein)
	Rancho de los Carrisalitos						Gold, washed. 20 miles west of Los Banos. (R 10: 330)
	Red Metal	Della French et al., 508 Powell St., Hollister.	32	11S	7E	MD	Quicksilver. Seams and pockets of cinnabar in quartz gangue. (R 8: 350; R 35: 402)
16	Richardson Sand and Gravel No. 1		15	8S	8E	MD	Sand and gravel. Portable plant on Garzas Creek. (Herein)
17	Richardson Sand and Gravel No. 2	Merced County	NE¼ 32	10S	10E	MD	Sand and gravel. Produces aggregate at Los Banos Creek with portable plant for County use. (Herein)
18	River Rock, Inc., No. 1	River Rock, Inc., Box 778, Merced.	26	5S	13E	MD	Sand and gravel. Mines and processes gravel from Merced River for aggregate and other uses. New moderate-sized plant. (Herein)
19	River Rock, Inc., No. 2 (Merced Sand and Gravel Co.)		35	5S	12E	MD	Sand and gravel. Mines gravel from Merced River with dragline and processes it in portable crushing and screening plant. (Herein)
4	San Joaquin Mining Co.	San Joaquin Mining Co., 1805 Mills Tower, San Francisco	13	5S	13E	MD	Gold, silver, platinum. Connected bucket dredge. Worked 3½ miles southwest of Snelling from 1937 to 1942. Shut down by L-208 in 1942. Dredge on property in Dec. 1951. Idle. (Herein; B 135: 262)
20	Silva Gravel	Manuel F. and Rita Silva, Box 77, Cressey.	3	6S	12E	MD	Sand and gravel. Slackline cableway and screening plant erected in 1950. Little production. Idle. (Herein)
21	Skov and Wychophen	Carlton E. Cunningham, leased to Skov and Wychophen, Rt. 1, Box 27, Turlock.	7	6S	12E	MD	Sand and gravel. New slackline cableway and screenhouse. (Herein)
	Slate		4,9	5S	15E	MD	Slate. Steeply dipping outcrops in vicinity of Merced Falls.

Merced County mineral deposits—continued.

Map no.	Claim, mine, or group	Owner	Location				Remarks*
			Sec.	T.	R.	B&M	
5	Snelling Gold Dredging Co.	Snelling Gold Dredging Co., Snelling.	3, 10 11, 12	5S	14E	MD	Gold, silver, platinum. Operated two connected bucket dredges in the area. Shut down in 1942 by L-208. Reactivated in 1946. One dredge operating in Dec. 1951. (Herein; R 31: 47; B 135: 262)
			4, 5, 6 7, 8, 9	5S	15E	MD	
8	Stayton	R. B. Knox, Hollister	SE¼ 5	12S	7E	MD	Quicksilver. Cinnabar veinlets filling fractures in fresh and kaolinized basalt. (R 43: 59; R 35: 429; R 15: 670; R 10: 515; R 8: 350; B 78:120; B 27: 147; U. S. G. S. B 931Q)
	Thurman and Wright	Crocker-Huffman Land and Water Co., leased to Thurman and Wright, 960 Russ Bldg., San Francisco.					Gold. Dragline dredge operation of short duration, during 1941. Partly in Merced and partly in Mariposa counties. (B 135: 262)
22	Turlock Rock Co.	Louise Meyer Jankins, Pebble Beach; leased to Turlock Rock Co., Turlock.	8	6S	12E	MD	Sand and gravel. Slackline cableway and new moderate-sized screening plant. (Herein)
	Victor Bonanza	Louis A. Franksen, c/o Ellen F. Wormley, 392 Hope St., Mountain View.	14, 15 16	13S	9E	MD	Copper. Native copper and chalcopyrite in outcrops. Little development work. (R 21: 179; R 17: 149; R 14: 605; B 144: 272; B 50: 171)
		E. H. Tryon & Co.	23, 24 25	13S	9E	MD	
		R. H. and E. E. Westphal	30, 31	13S	10E	MD	
	Warfield, C. A. H.						Clay. Bricks made on southeast bank of Bear Creek, 1 mile from center of Merced; pre-1890. (R 10: 331)

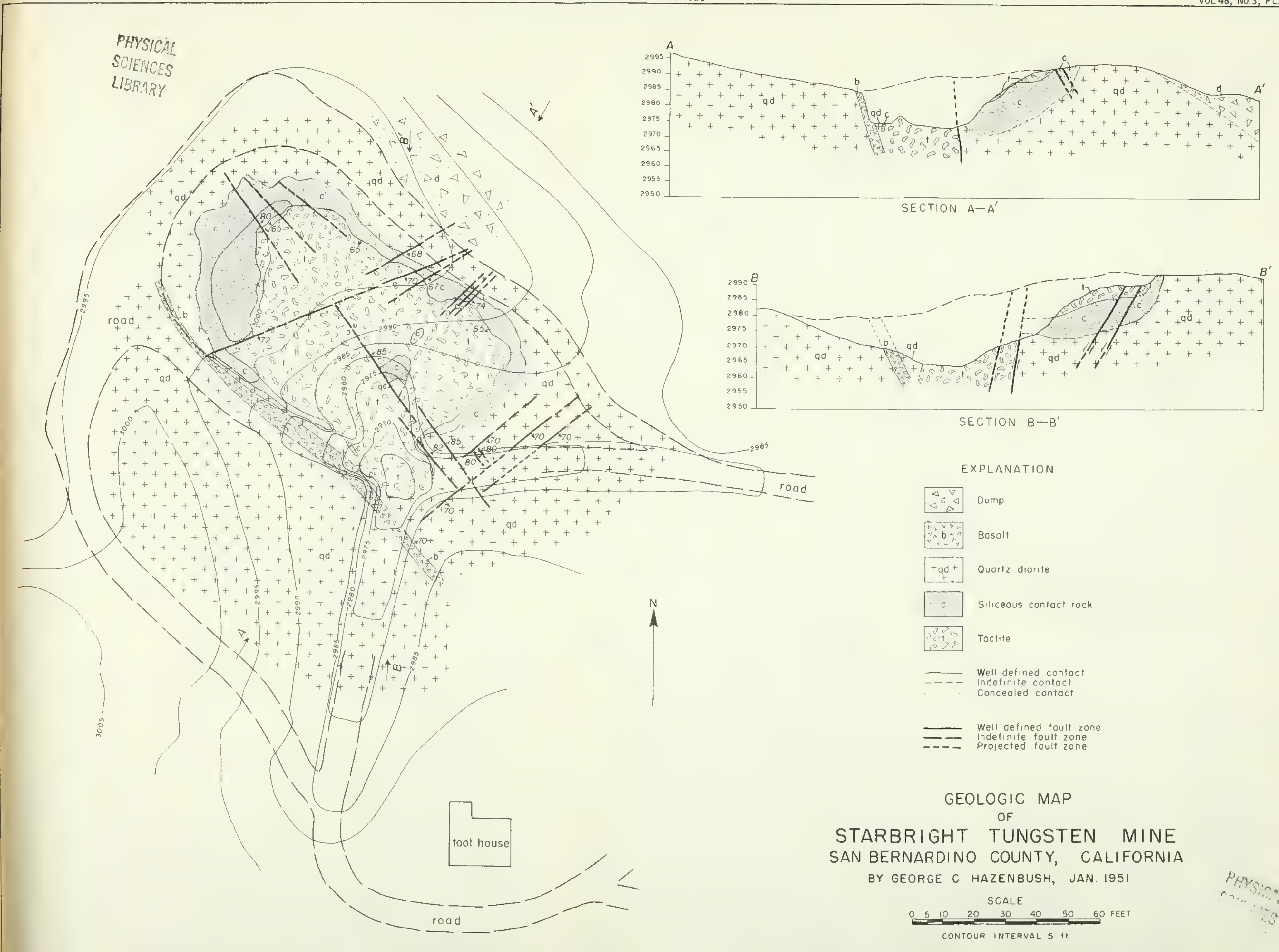
23	Wood, C. C.	U. S. Government	SE¼ 32	10S	10E	MD	Sand and gravel. Gravel bank of Delta Mendota Canal is screened and used for canal road rock.
	Woody						See Gypsy
9	Yellowjacket	R. B. Knox, Hollister	SE¼ 5	12S	7E	MD	Quicksilver. Thin cinnabar seams in quartz veins. Workings in fresh and kaolinized basalt. (U. S. G. S. B 931Q: 53)
	Yosemite Mining and Dredging Co.		9	5S	14E	MD	Gold, silver, platinum. First connected bucket-dredge on Merced River. Operated south of Snelling from 1907 to 1919. (R 21: 181; R 14: 606; B 85: 33, 105; B 57: 211)
	Yosemite Portland Cement Corp.	Permanente Cement Co., Permanente.	SW¼ 12	7S	13E	MD	Clay. Used some local clay in making cement. (Herein; R 21: 179; B 99: 128)
	Yuba Consolidated Gold Fields (La Grange Gold Dredging Co.)	William and Laurence Jenkins, Snelling.	1, 12 7	5S 5S	14E 15E	MD MD	Gold, silver, platinum. Operated two connected bucket dredges between 1935 and 1939. (Herein; R 31: 47; B 135: 262)

* The following abbreviations are used in this column: B-Bulletin, California Division of Mines; PR-Preliminary Report, California Mining Bureau; R-Report of the State Mineralogist, California Division of Mines; USGS B-United States Geological Survey Bulletin; USBM MY-United States Bureau of Mines Minerals Yearbook.

o

56800 1-52 2M

printed in CALIFORNIA STATE PRINTING OFFICE



GEOLOGIC MAP
OF
STARBRIGHT TUNGSTEN MINE
SAN BERNARDINO COUNTY, CALIFORNIA
BY GEORGE C. HAZENBUSH, JAN. 1951

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 48 OCTOBER 1952 No. 4

CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
OLAF P. JENKINS, Chief

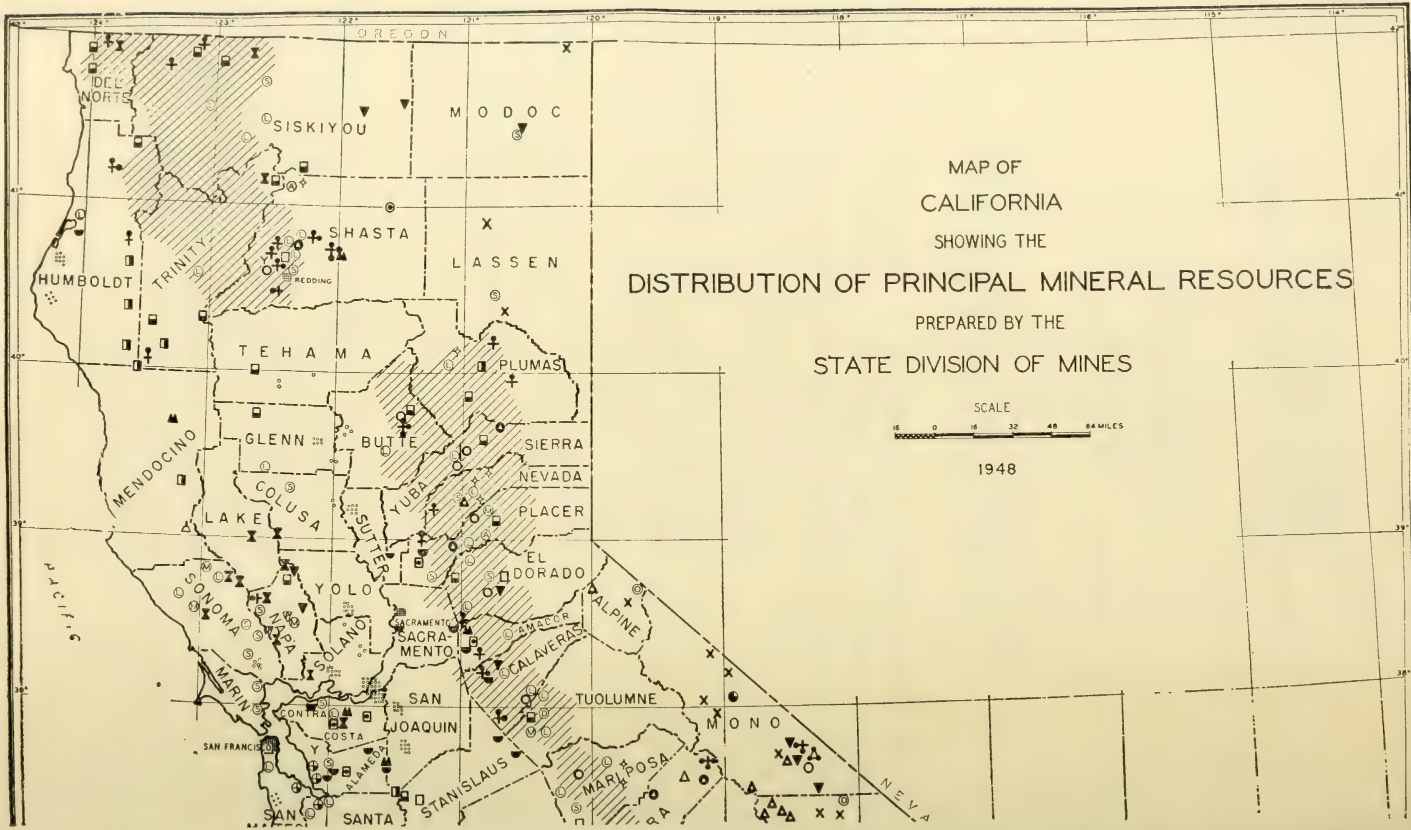
Headquarters
Third Floor, Ferry Building, San Francisco 11

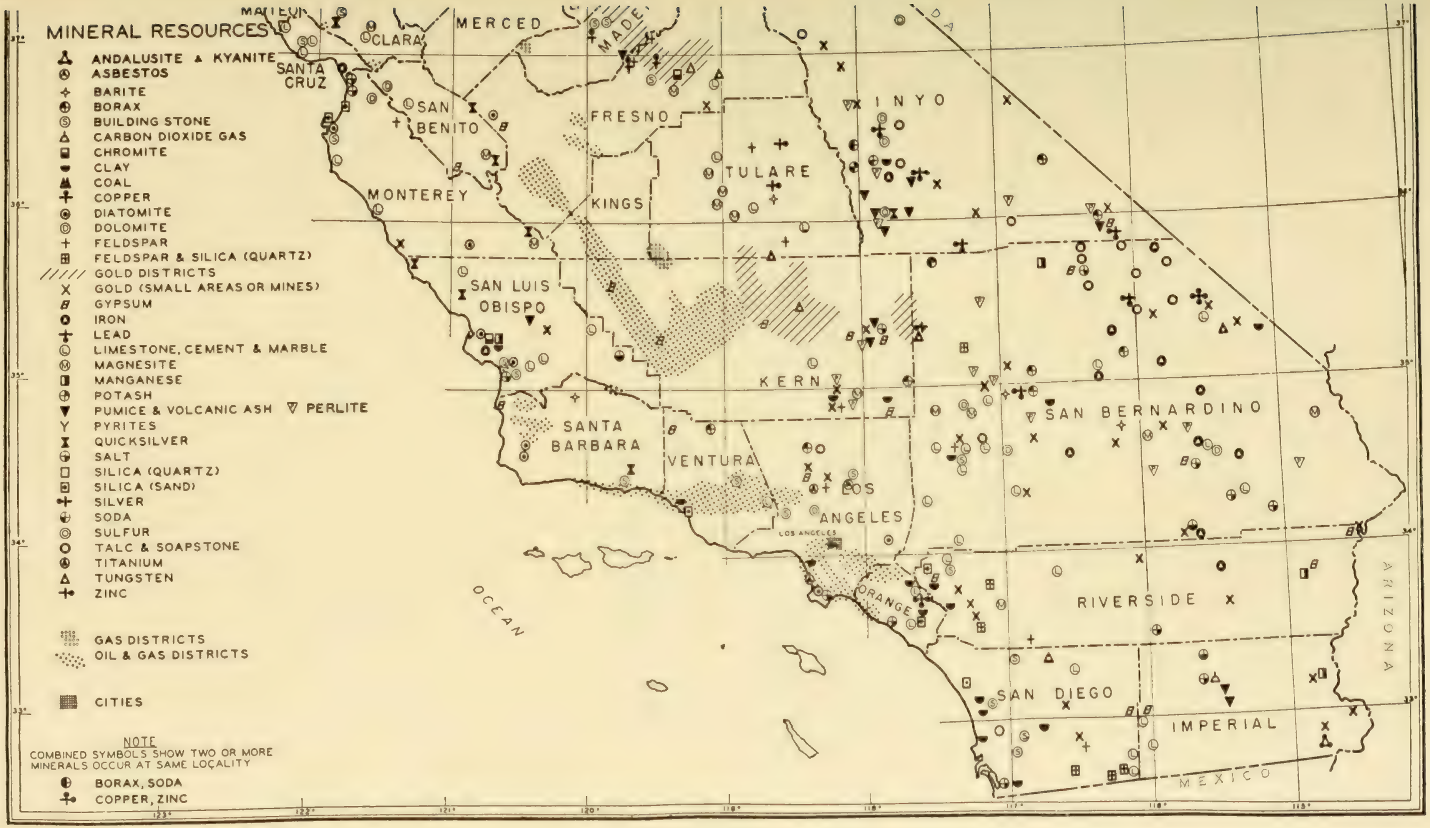
Branch Offices
State Building, 217 West First Street, Los Angeles 12
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
REDDING
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
COLUSA
YUBA
PLACER
LAKE
SUTTER
EL DORADO
YOLO
SONOMA
NAPA
SOLANO
SACRAMENTO
SACRA-MENTO
AMADOR
ALPINE
CALAVERAS
MARIN
SAN JOAQUIN
TUOLUMNE
CONTRA COSTA
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA
NEVA
PACIFIC


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY
BORAX, SODA
COPPER, ZINC
SANTA CRUZ
CLARA
MERCED
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

PLATES

MINES AND MINERAL RESOURCES OF DEL NORTE COUNTY, CALIFORNIA

By J. C. O'Brien *

OUTLINE OF REPORT

Illustrations

ABSTRACT

Del Norte County, situated in a rugged mountainous area in the extreme northwest corner of California, is still largely undeveloped. Lumbering is the principal industry with an output of more than 100 million board feet in 1950. The 45,000 acres and more devoted to farming and other agricultural pursuits had a total income of $2,144,000 in 1950, principally from dairy products and livestock. Commercial fishing boats, based at Crescent City harbor, contributed $563,852 to the county's income, principally from the sale of crab and salmon. There are many recreational features to enjoy in the county and sportsmen from all parts of the country are attracted by the hunting and fishing. The Redwood groves, rivers, streams and rugged seacoast are enjoyed by thousands of tourists each year.

The county is wholly within the Klamath Mountain geomorphic province which is characterized by rugged topography and complicated stratigraphy and structure. Ultra-basic Mesozoic intrusive rocks, chiefly serpentine and peridotite, are exposed over most of the area; other rocks are a belt of Franciscan sandstone and shales 5 to 10 miles wide along the coast and the diorite and granodiorite of the Siskiyou Mountains along the county's eastern border. Small areas of diorite and granodiorite also occur in the serpentine belts, and there are remnants of metamorphic, sedimentary, and volcanic rocks which have been intruded by both the granitic rocks and the peridotite. All the chromite deposits occur as lenses in serpentine. Copper minerals, chalcocite, cuprite, malachite, chalcopyrite, and native copper occur in veins and lenses in serpentine usually at or near the contact with granitic rocks. Pyrite and pyrrhotite are accessory minerals. Gold and platinum are found in the stream gravel and beach sand associated with magnetite and chromite. Gold also occurs in narrow quartz veins and stringers in greenstone and slate near the contact with diorite and granodiorite. Native quicksilver and cinnabar occur in vugs and fissures in serpentine and the rocks in contact with it. Sand and gravel are mined intermittently from the banks and bars of the Smith River and the heavy rock used to build the Crescent City jetties was quarried from the Franciscan formation on Preston Island and at Point St. George.

Copper mining was active in the Low Divide district east of Smith River during Civil War years and high grade ores were shipped to Wales and Germany for treat-

* District mining engineer, California Division of Mines. Manuscript submitted for publication March 1952.

ment. The copper minerals also carried some gold and silver. The low price of copper and the high cost of mining, freight and treatment resulted in closure of the mines after the war. One of the principal old copper producers was being reopened in 1951.

Chromite mining, like copper mining, was active in the early 1860's and 1,500 to 2,000 tons of chrome ore were mined annually from 1860 to 1889 in the High Divide district and shipped around Cape Horn to Baltimore, Maryland. When the tariff was removed from chromite in 1894, the price dropped and the domestic mines were closed. They have remained closed except for periods of abnormally high prices such as that during the war years. Del Norte County is the principal producer of high grade lump chromite in the United States, having a recorded production of more than 70,000 long tons.

Gold mining has been inactive in recent years and the gold production to date has come principally from the early day placer operations along the Smith River and its tributaries. No important gold quartz mine has been developed in the county.

INTRODUCTION

Del Norte County was created on March 2, 1857. The territory within its present boundaries was originally a part of Trinity County[1] which at one time included all the drainage basin of the Klamath River and its tributaries. In 1851 the northern half of this large area was organized as Klamath County. A part of Klamath County was included in Siskiyou County when it was created in 1852 and another portion was assigned to Trinity County in 1855. The eastern boundary of Del Norte County was moved three times between 1857 and 1887 when the present boundary was drawn. Klamath County was dissolved in 1875, part being added to Humboldt and part to Siskiyou County.

Geography. Del Norte County is situated in the extreme northwest corner of California and is bounded on the north by the State of Oregon, on the east by Siskiyou County, on the south by Humboldt County, and on the west by the Pacific Ocean. It includes a land area of 641,920 acres of which 68 percent or 437,600 acres is publicly owned, mostly as national forest. The 1950 census reported a population of 8,078, a gain of 69.2 percent over the 1940 figure. Crescent City, the county seat and largest city, is located on the coast near the middle of the west boundary. The city has a harbor protected by rock jetties which provide safe anchorage for shipping and for fishing boats.

Topography. A coastal plain 4 to 6 miles wide extends 13 miles northward from Crescent City to the mouth of the Smith River where the plain narrows to a half-mile strip and continues 4 miles northward to the Oregon border. Southeastward from Crescent City, the coastal plain continues a distance of 4 miles, at which point it terminates against the mountains; the remainder of the shoreline is rugged and rocky. The Klamath Mountains form the eastern boundary of the coastal plain and extend northward through the central portion of the county. The crest of the Siskiyou Mountains with peaks up to 6,000 feet elevation forms the eastern boundary.

The Smith River with its South, Middle and North Forks provides drainage for most of the county and empties into the Pacific Ocean about 4 miles south of the Oregon border. The Klamath River crosses the southwest corner of the county and empties into the ocean at Requa, about 8 miles north of the Humboldt County line.

[1] Coy, Owen C., California county boundaries; California Historical Survey Commission, Berkeley, pp. 94-96, 1923.

Transportation. Del Norte County is traversed in a north-south direction by the Coast Highway (U. S. 101) which connects Crescent City with Astoria, Oregon to the north and Eureka and San Francisco to the south. The Redwood Highway (U. S. 199) originates at Crescent City and crosses the county in a northeasterly direction, connecting with U. S. Highway 99 at Grants Pass, Oregon, a distance of 87 miles. Steep, rough, mountain roads and trails are the only means of access to areas beyond the highways; many areas are without roads. Motor bus and truck lines serve cities along the highways and Crescent City is one of the regularly scheduled stops of Southwest Airways. There are no railroads serving the county. Extensive lumber shipments are made by boat from Crescent City harbor.

Climate. The climate along the coast is mild with an average annual temperature of 52.4 degrees; the highest temperature on record is 102 degrees which occurred in July, and the lowest temperature is 23 degrees. The rainy season lasts from October to May and the average annual precipitation is 74.28 inches. More severe climatic conditions exist in the mountains and there is a considerable snowfall at the higher elevations.

Industries. Lumbering is the principal industry in Del Norte County and in 1950, 31 lumber mills had an output of more than 100 million board feet,[2] mainly redwood and Douglas fir. It is estimated that the total redwood resources amount to more than 13 billion board feet. There are also stands of cedar, fir, oak, alder, hemlock, yew, maple, madrone, myrtle and spruce. The harbor at Crescent City is home port for 130 commercial fishing boats and the commercial fishing industry had a total income of $563,852 in 1950, principally from the sale of crab and salmon.

Agriculture. There are approximately 45,000 acres in farms mostly in the Smith River Valley and the major agricultural activity is dairying. Dairy, poultry and livestock products were valued at $1,397,500 in 1950. Easter lily, nursery stock and other farm products were valued at $746,500 making a total income for agriculture of $2,144,000.

Recreation. Del Norte County has a valuable natural resource in its recreation facilities. Sportsmen from all parts of the country are attracted by the hunting and fishing; and the redwood groves, rivers, streams and rugged seacoast are enjoyed by thousands of tourists each year.

GEOLOGY

Del Norte County lies wholly within the Klamath Mountains geomorphic province which is characterized by a rugged topography and a complicated stratigraphy and structure. The general geology of the area was mapped by Hershey [3] in 1911 and by Maxson [4] in 1933 and is shown on the geologic map of California prepared by Jenkins [5] in 1938. The physiography is in part discused by Diller.[6] A topographic map show-

[2] Industrial data and report on industrial development: Del Norte County, California, 1951; Del Norte County Chamber of Commerce.
[3] Hershey, O. H., Del Norte County geology: Min. and Sci. Press, vol. 102, p. 468, 1911.
[4] Maxson, J. H., Economic geology of Del Norte and Siskiyou Counties: California Jour. Mines and Geology, vol. 29, pp. 123-160, 1933.
[5] Jenkins, O. P., Geologic map of California, scale 1:500,000: California Div. Mines, 1938.
[6] Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, pp. 31-35, 1902.

ing the distribution of peridotite was prepared by Wells[7] in 1946 and it is in these rocks that most of the economic minerals of the county have been found.

The western part of the county, for a distance of as much as 10 miles from the ocean, is mostly underlain by sandstone and shale with intercalated volcanic rocks.[8] The sandstone is dark gray in color, and is made up of thoroughly hardened arkosic material. This rock occurs in thick layers that show little bedding. Shale, which is much less abundant, forms thin layers interbedded with the sandstone. Lenses of chert are common in the lower part of the formation. Intercalated with the sediments are large masses of green, generally fine-grained igneous rocks, consisting of volcanic flows and agglomerates, and both the sedimentary and the volcanic rocks are cut by dikes and larger intrusive bodies of dioritic composition. The stratified rocks are probably to be correlated with the Franciscan formation, which is probably of Jurassic age.

Metavolcanic and metasedimentary rocks of Triassic age, studied in the Kerby quadrangle, Oregon[9] extend south-southwestward through the eastern part of the county, with steep easterly dips. Downfaulted against these rocks on the west is the Galice formation, of Upper Jurassic age, which has been traced into Del Norte County from Galice, Oregon, and is correlated with the Mariposa formation of the Sierra Nevada province.[10] In its type locality the Galice formation consists mainly of black indurated shale, partly metamorphosed into slate, but it includes arkosic sandstone with intercalated volcanic material.

The Mesozoic sedimentary and volcanic rocks have been intruded by peridotite which has been altered to serpentine. The serpentine may be regarded as forming three belts.[11] By far the most extensive is the middle belt which consists mainly of the southern part of the great Josephine mass, which extends from the state line, about 50 miles northward into Oregon and 18 miles southward into Del Norte County. It is almost 10 wide at the Oregon border but narrows down to about a mile in width on its southern end. Two relatively small outliers are also included in this belt, one to the southwest, at Lower Coon Mountain, and one to the south, at Summit Valley. The second in extent is called the southwestern belt. This is joined to the middle belt by a narrow strip running north from Smith River from which it extends southeastward, beyond the southern boundary of the county. It is narrow in comparison with its great length but reaches a maximum width of 3 miles at Little Rattlesnake Mountain. The eastern serpentine belt includes irregular areas lying east and southwest of the middle belt, partly within Del Norte County but extending into Siskiyou County and Oregon. The largest area in the eastern belt is the one that includes Ship Mountain. It has a maximum width of $2\frac{1}{2}$ miles and extends northward from the South Fork of Smith River for about 15 miles. The second largest area in the eastern belt

[7] Wells, F. G., Topographic map of Del Norte County, California showing distribution of peridotite and location of chromite deposits: California Div. Mines Bull. 134, pt. 1, pl. 1., 1946.
[8] Wells, F. G., Cater, F. W., Jr., and Rynearson, G. A., Chromite deposits of Del Norte County, California: California Div. Mines Bull. 134, pt. 1, chap. 1, p. 76, 1946.
[9] Wells, F. G., and Hotz, P. E., Mesozoic volcanic series in southwest Oregon: (abstract) Geol. Soc. America Bull., vol. 52, pt. 2, pp. 1937-1938, 1941.
[10] Diller, J. S., and Kay, G. F., U. S. Geol. Survey Geol. Atlas, Riddle folio (no. 218), p. 3, 1924.
[11] Wells, F. G., op. cit. pt. 1, 1946.

is in the Bear Camp Ridge—Doe Flat area where a narrow strip of highly sheared serpentine extends south from the Oregon border to Doe Flat, a distance of 12 miles.

Small bodies of diorite and granodiorite have been intruded into the pre-Tertiary sedimentary rocks and the serpentine, especially in the eastern part of the county. The Siskiyou granodiorite in that area [12] is a coarse-grained plutonic rock containing green hornblende, biotite, sodic plagioclase, and quartz with apatite and magnetite as accessory minerals. It is correlated with the granodiorites of the Sierra Nevadan batholith of late Jurassic age. It was observed to intrude the Preston hornblende diorite (late Paleozoic?)[13] and serpentine, but to be intruded by the Patrick greenstone of supposed Cretaceous age. The Preston hornblende diorite is commonly a fine-grained, gray rock closely cut by quartz veins. Green hornblende is more characteristic than brown, though both are present. Moderately calcic plagioclase is the other important constituent.

The Patrick greenstone includes fine-grained intrusive diorites and andesites containing green hornblende and sodic plagioclase with smaller amounts of sericite and pyrite. With quartz present they grade into quartz diorites and dacites, being occasionally porphyritic. The greenstone is in various stages of hydrothermal alteration.

Faulting is prominent and contacts with serpentine usually show displacement. Three major fault zones are mapped.[14] To the east, the Orleans fault of Hershey, a steeply dipping reverse fault, separates the igneous-metamorphic rocks on the east from the Jurassic meta-sediments and intrusives. The throw has been several thousand feet.

A second line of faulting strikes northwestward along the west face of the Bald Hills which have been uplifted 400 feet with respect to the area to the west. This fault may continue northwestward to join the Del Norte fault. The plane of the Del Norte fault has nowhere been observed but is inferred to block out the Crescent City platform and to lie offshore to the south.

Recent uplift has initiated very rapid erosion in Del Norte County and the streams have cut deep, narrow canyons. Landslides have taken place on a considerable scale, particularly along streams that cut through areas of serpentine.

MINES AND MINERAL RESOURCES

The recorded value of the mineral production of Del Norte County from 1880 to 1949 amounted to $6,258,754. Gold, silver, copper, chromite and quicksilver production before 1880 is not recorded. These substances, with the addition of platinum and miscellaneous stone comprise the commercial minerals produced in the county. The output of chromite, copper, and quicksilver is dependent on high prices such as occur in war years and times of national defense. In other years, the remoteness from markets, the high cost of transportation, and the lack of access roads have made it uneconomic to develop and mine deposits of these minerals. The principal mining activity in recent years has been in the production of high-grade lump chromite for the war emergencies. Descriptions of properties now

[12] Maxson, J. H., op. cit. pp. 131-134, 1933.
[13] Maxson, J. H., op. cit. pp. 128-134, 1933.
[14] Maxson, J. H., op. cit. pp. 136-137, 1933.

Mineral production of Del Norte County, 1880-1949.

Year	Gold, value	Silver, value	Platinum		Miscellaneous stone, value[1]	Miscellaneous and unapportioned		
			Ounces	Value		Amount	Value[2]	Substance
1880	$215,403	$300						
1881	60,000							
1882	80,000							
1883	135,000							
1884	100,000							
1885	39,390	9						
1886	76,189							
1887								
1888								
1889	21,800							
1890	900							
1891	5,586							
1892	4,102							
1893	10,352							
1894	8,000							
1895	8,250							
1896	24,150							
1897	16,710							
1898	9,057							
1899	4,450							
1900	3,483							
1901	10,612							
1902	5,450							
1903	7,183							
1904	7,399		1.5	$18				
1905	10,590		1.5	22				
1906	5,945	33						
1907	878	3						
1908	3,488	19				74,787 lbs.	$9,984	Copper
1909	1,610	52				24,449 lbs.	13,085	Copper
							20,000	Unapportioned, 1900-09
1910	2,388	62				26,670 lbs.	3,395	Copper
1911	1,743	7						
1912	3,940	10						
1913	2,498	16						
1914	2,035	9	14	643	$3,250			

1915	1,018	6			3,500			
1916	405	2	2	73	1,685		267	Chromite and copper
1917	1,373	8	10	853	2,700	3,275 tons	97,255	Chromite
							2,151	Other minerals
1918	565	4	1	97	8,000	7,143 tons	360,485	Chromite
							2,584	Other minerals
1919	867	6			6,300		67	Other minerals
1920					9,000		2,781	Chromite and copper
1921	[3]	[3]		[3]	5,580		449	Gold, platinum, silver
1922	[3]	[3]		[3]	5,500		761	Gold, platinum, silver
1923	1,778	9		[3]	31,368		872	Copper and platinum
1924	325			[3]	721,720		220	Unapportioned
1925	681	1			269,650		250	Other minerals
1926	1,078	4	10	1,132	68,250			
1927	384	1			53,350		240	Other minerals
1928	277	1			381,080			
1929		3			83,380	5,002 lbs.	880	Copper
1930	279	1			275,227		523	"Unapportioned"
1931	1,372	1			36,702			
1932	2,195	2			23,416		188	Unapportioned
1933	1,933	3		[3]	[3]		1,126	Platinum, miscellaneous stone
1934	6,078	13		[3]	73,883		24	Unapportioned
1935	4,798	3			41,788		4,529	Gold, silver, platinum
1936	[3]	[3]		[3]	12,247		28,014	Chromite, miscellaneous stone
1937	2,625	8			[3]			
1938	700	1			15,296			
1939	4,410	15		[3]	7,250		1,426	Chromite, platinum
1940	1,750	3			[3]		22,936	Chromite, miscellaneous stone
1941	1,365	2		[3]	18,250		92,636	Chromite, platinum
1942	175	2			18,709		382,367	Unapportioned
1943					42,537		567,127	Chromite, quicksilver
1944	105				17,748	11,040 long tons	491,141	Chromite
							709	Unapportioned
1945					23,685		317,621	Chromite, quicksilver
1946	840	17			66,565		24,497	Chromite, copper, quicksilver
1947							322,156	Chromite, sand and gravel, unapportioned
1948							186,902	Chromite, mercury, sand and gravel, stone
1949							144,969	Chromite, mercury, sand and gravel, stone
	$925,957	$636	40	$2,838	$2,327,616		$3,104,617	
Grand total				$6,361,664				

[1] Includes crushed rock, rubble, rip-rap, sand, gravel.
[2] Gold, copper and chromite were produced in Del Norte County earlier than the years shown, but the amounts are not separable by counties. Some quicksilver was obtained in the 50's but there is no record of amount.
[3] See under Unapportioned.

idle but once active are summarized in the table of mines from earlier reports. Many of these old properties are now abandoned.

Black Sand

The beach sand of the coastal plain and the gravel in the Smith River basin include a large amount of black sand containing magnetite and some chromite. They also carry some very finely powdered gold and platinum, but the recovery of these metals has been successful on a small scale only. A plant designed to process 800 cubic yards of sand per 24 hours was erected [15] on the beach 2 miles south of Crescent City in 1913. The sand was pumped to a revolving screen from which it was distributed over a series of aluminum plates having riffle grooves and from there to a metal plate of undisclosed composition. An alternating current was passed through the plates and was supposed to separate the black sand from the gold and platinum. The plant was a metallurgical and financial failure and no trace of it remains. The most successful recovery of gold and platinum from beach sand has been made with a duck-board riffle fastened to a plank bottom which is set near the edge of the sea when the tide is coming in and kept in such a position that the outgoing waves wash the gold-bearing black sand over it. No sustained attempt has been made to work the black sand for gold or platinum in recent years.

Chromite

Del Norte County is the largest producer of lump chromite in the United States having a recorded production of over 70,000 long tons. Chromite was first mined at the Mountain View mine at High Divide in the early 1860's by the Tyson Mining Company of Baltimore, Maryland. Little is recorded about the ore produced in these early operations but Crippen [16] states that 1500 to 2000 tons of ore were shipped annually from 1860 to 1889 from Crescent City around Cape Horn to Baltimore. When the tariff was removed from chromite in 1894 the domestic price dropped and Del Norte County production ceased. During World War I deposits were mined in the Copper Creek, French Hill, High Plateau, and Low Divide districts. At the end of the war in 1918, foreign ores were again available and the price of chromite dropped abruptly. The mines were shut down and remained idle until the price rose in 1936. The Metals Reserve Company established a purchasing depot at Grants Pass, Oregon in 1942 where small lots of chromite could be sold. This made it possible to mine small lenses of chromite, many of which yielded less than 100 tons.

Practically all the deposits mined were lenses or pods of massive chromite occurring in dunite or serpentine. There was no apparent reason why chromite formed in one mass of dunite rather than in another, or in a particular portion of the mass. It has been observed, however, that many of the deposits were found in shear zones and that in most of them the dunite was more or less altered to serpentine. Seventy-one deposits in Del Norte County are listed by Wells [17] as having yielded a total of 58,430 long tons of ore to December 31, 1944. Most of the chromite mined con-

[15] Lowell, F. L., Del Norte County: California Min. Bur. Rept. 14, pp. 375-379, 1914.

[16] Crippen, R. A., Jr., Mineral Commodities of California, Chromite: California Div. Mines Bull. 156, pp. 294-298, 1950.

[17] Wells, F. G., Geological investigations of Chromite in California: California Div. of Mines Bull. 134, pt. I, ch. 1., pp. 21-26, 1946.

FIGURE 1. Chrome Hill No. 1 mine.

Figure 2. Mountain View chrome mine (1943).

FIGURE 3. Quarry at Point St. George.

FIGURE 4. Preston Island quarry.

tained more than 40 percent Cr_2O_3 and had a chromium-iron ratio higher than 2.50.

Big Dipper (Camp 7, Rowan), is on the steep east slope of Gordon Mountain in the SW¼ sec. 7, T. 16 N., R. 3 E., H. It was owned by Mrs. Floyd Peuten and leased and operated by C. H. Bennett of Syms Camp and J. K. Remsen of Grants Pass, Oregon in July 1942. Lump chromite as float and in pods in serpentine was mined from cuts along a shear zone striking N. 15° E. The sorted ore was loaded into a bucket of 1500 pounds capacity and hoisted over a cable tram about 1,000 feet long and stored in a wooden ore bin at the end of a road over which it was hauled about 86 miles to the stockpile at Grants Pass, Oregon. The bucket was hoisted with a single drum hoist geared to a 6-cylinder automobile engine. Four men were employed at the mine. Shipments totaling 339 long tons were made to the Metals Reserve Company in 1942 and 1943. Analysis of the ore shipped in 1943[18] gave 42.70 to 43.54 percent Cr_2O_3, and a chromium-iron ratio of 2.49 to 2.62. The property has been idle since 1943.

Billy Boy (Hawkins, Divide) is in sec. 29, T. 16 N., R. 2 E., H., and was owned by William Hawkins and leased and operated by C. H. McClendon of Crescent City in 1943-1944. Chromite that occurred in pods in serpentine was mined from surface cuts with a bulldozer. About 500 long tons of ore were shipped to Metals Reserve Company at Grants Pass, Oregon and Arcata, California from the Hawkins and the adjoining Fourth of July claims in 1944. McClendon said the ore averaged 38 to 40 percent Cr_2O_3 and had a chromium-iron ratio of 2.2. Three men were employed at the property in August 1945, shortly after which it was closed and has remained idle.

Bluebird (High Point) group includes 10 claims in sec. 29, T. 18 N., R. 2 E., H., that were owned and operated by J. E. Eckett, H. D. Miller and Ernest Tarbell of Cave City, Oregon in 1943 and 1944. Lenses of chromite 2 to 6 feet wide in serpentine were mined in three open cuts trending N. 30° E. The partners built about 2 miles of access road from the Judy mine and shipped 120 long tons of ore to the stockpile at Grants Pass in 1944. The property was idle in October 1951.

Bonanza claim is in sec. 21, T. 18 N., R. 2 E., H., about half a mile north of the High Plateau mine. It is owned by Delbert O'Brien and Donald F. Johnson of O'Brien, Oregon. Chromite occurred in lumps and stringers in a shear zone in serpentine. O'Brien and Clifford Johnson mined and shipped 149 tons of ore to the Metals Reserve Company stockpile at Grants Pass in 1942. The ore assayed 48 to 50.5 percent Cr_2O_3 and had a chromium-iron ratio of 2.82. The property was idle in October 1951.

Camp 8 (St. Patrick) claim is near the center of sec. 19, T. 16 N., R. 3 E., H., 88 miles by road from Grants Pass, Oregon. It was owned and operated by C. H. Bennett of Syms Camp and J. K. Remsen of Grants Pass in 1942. Lumps of chromite were sorted from the red soil and gray serpentine found in a fault zone trending N. 50° W. Five men were employed and 27 long tons of 40 percent Cr_2O_3 were shipped to Grants Pass, Oregon. The property has been idle since 1944.

[18] Wells, F. G., Geological investigations of chromite in California: California Div. Mines Bull. 134, pt. I, ch. 1, p. 58, 1946.

Chrome Hill No. 1, (Theone, Hance & Webb) is in sec. 29, T. 18 N., R. 3 E., H. It is owned by Donald Raymond, Gasquet, California. Chromite occurs in a narrow stringer striking N. 10° E. and dipping 65° E. in serpentine and as float in the brown-colored top soil. The deposit was first worked by J. A. Hance and D. L. Webb of Kerby, Oregon. In July 1943 it was acquired by Don Raymond, the present owner, who mined and shipped 20 long tons of ore in that year that assayed 45.9 percent Cr_2O_3, with a chromium-iron ratio of 2.77.[19] In August 1951 the property was leased to E. A. Carlson and in October 1951 it was operated by a partnership including Carl Verstegen, Harvey L. David and Rome Holtzhauser of Cave Junction, Oregon. A truck road about three-quarters of a mile long was built from the Patrick Creek road to the property. A bulldozer cut uncovered a stringer of chromite up to 4 inches thick frozen to a dunite wall striking N. 10° E. and dipping 65° E. About 12 tons of sorted ore was shipped to the stockpile at Grants Pass, Oregon in October 1951.

Copper Creek (Low Divide, Rowdy Creek) mine is on patented land on Rowdy Creek and is described as Mineral Lot 39 in the SW¼ sec. 26, T. 18 N., R. 1 E., H. It was first worked about 1880 by the Tyson Mining Company of Baltimore, Maryland who mined and stockpiled about 700 tons of ore from a large open cut. The property was leased to the American Exploration and Construction Company and operated under a sublease by R. D. Adams and C. S. Maltby of San Francisco in 1917 and 1918.[20] They produced 2,876 long tons of ore before the price of chromite dropped in 1918. The property lay idle from 1918 until it was purchased by the Tyson Chrome Mines, Ltd. in 1942 and leased to C. A. Gillis, W. E. Gillis and G. Brandi. The leasers mined and shipped 239 long tons of ore averaging 41.2 percent Cr_2O_3 with a chromium-iron ratio of 2.56 before suspending operations in the fall of 1943. Massive chromite occurred in pods and stringers in a shear zone trending N. 70° W. in serpentine. It was mined in open cuts; in a glory hole above an adit driven N. 80° E.; and in underhand stopes. The lowest workings were about 50 feet below the outcrop and the ground was heavy. The mine was closed in 1943 when C. A. Gillis was fatally injured by a fall of ground and it has been idle since.

Dipper Extension claim is in the High Plateau district in sec. 28, T. 18 N., R. 2 E., H. It was located May 25, 1942 by Eugene Brown and Charles P. Johnson of O'Brien, Oregon. The chromite was disseminated in dunite and about 10 tons were mined from a trench 25 feet long, 30 inches wide and extended to a maximum depth of 15 feet. The ore was low grade and the property lay idle from 1943 until it was relocated by Ted Terrel of Kerby, Oregon in 1951. Two men were employed in October, 1951 stripping brush from the surface with a bulldozer and prospecting the serpentine outcrop. About 3 tons of ore, mostly float but including some taken from narrow stringers, was stockpiled.

Egger's claim is in sec. 29, T. 18 N., R. 3 E., H. It was located by J. B. Hearing and D. L. Webb of Kerby, Oregon in July 1943 and was leased and operated by J. W. Eggers and sons of O'Brien, Oregon.

[19] Wells, F. G., op. cit., p. 55, 1946.
[20] Bradley, W. W., Manganese and chromium in California: California Min. Bur. Bull. 76, pp. 125-127, 1918.

About 30 tons of ore were mined from shallow bulldozer cuts in serpentine. The property has been idle since 1943.

Fourth of July claim is in sec. 29, T. 16 N., R. 2 E., H. It is owned by C. H. McClendon of Crescent City. Chromite occurred in lenses in a shear zone in serpentine and was mined with a bulldozer from an open cut 125 feet long, 70 feet wide and about 20 feet deep. Three men were employed mining and sorting the ore and about 100 tons of 38 percent Cr_2O_3 was shipped to the Metals Reserve Company stockpile at Arcata in 1944. McClendon was still operating the property in August 1945 and shipping ore he said would average 38 to 40 percent Cr_2O_3 with a 2.2 chromium-iron ratio. The property has been idle since 1945.

French Hill (Tyson) mine is in the NE¼ sec. 6, T. 16 N., R. 2 E., H. and includes the French Hill claim, patented by the Tyson Mining Company of Baltimore, Maryland as Mineral Lot No. 37 in 1886, and the Chrome Ridge 1, 2, 3, and 4 claims, located in 1941. The property had a recorded production of over 4,000 long tons during 1917-1918 and then lay idle until 1941 when it was operated under a lease by C. H. McClendon of Crescent City who mined 495 tons of 44 percent Cr_2O_3 ore. The Tyson Chrome Mines, Ltd. acquired the property in 1942 and from June 1942 to August 1946 mined over 20,000 tons of ore averaging about 44 percent Cr_2O_3 with a chromium-iron ratio of 2.5. Massive chromite occurred in lenses in a shear zone trending northwestward in serpentine. Some of the lenses were separated by only a few feet of rock. The uppermost ore body was about 60 feet long, 30 feet wide, and 8 feet thick and was mined by an open cut and side-sets from an adit driven N. 20° W. for 30 feet. About 60 feet southwest of the portal of the adit, an inclined shaft was sunk 35 feet deep on a 35 degree slope in a N. 5° W. direction. A crosscut driven 20 feet west from the bottom of the shaft intersected the intermediate ore body which was about 75 feet long, 60 feet wide and 6 feet thick. The lowest and largest ore body was mined through an incline shaft 115 feet deep on a 70 degree slope. The collar of the shaft, located about 25 feet south of the 35 degree incline shaft, was sunk through massive chromite between the 25 and 60 foot depths. An adit driven N. 50° E. 175 feet to the shaft at the 55 foot level was in ore for the last 35 feet. The orebody was 100 feet long, 70 feet wide and 35 feet thick and was mined with square sets using 8- by 8-inch square timbers with 7-foot posts at 5-foot centers. The ground was heavy and the sets had to be braced and filled close to the working face.

The U. S. Geological Survey mapped this property in 1942-1943 and in 1944 the U. S. Bureau of Mines drilled 14 diamond drill holes from 80 to 140 feet deep aggregating 1,575 feet.[21] Much of the subsequent production was taken from ore bodies developed by these drill holes. The property continued in production through 1945 after the Metals Reserve Company stopped purchasing ore. Eight men were employed in May 1946 and Grant Hardy, foreman said they were shipping about a carload of ore a week to San Francisco which was averaging 38 to 42 percent Cr_2O_3 with a 1.85 to 2.1 chromium-iron ratio. The ore was being mined by underhand stoping from a drift 150 feet north of the shaft. No new ore was developed in a new vertical shaft which was sunk 135 feet deep at a location 150 feet northwest of the working shaft.

[21] Sanborn, W. C., and Ricker, Spangler, Investigation of French Hill chromite mine, Del Norte County: U. S. Bur. Mines Rept. Inv. 4365, pp. 1-9, 1948.

The Tyson Chrome Mines Ltd. sold its mining equipment and leased its Del Norte County mines to Sam J. Wilson of Crescent City in August 1946. Eight additional diamond drill holes were drilled from the Tyson adit and some new ore bodies were found. In 1947 Wilson and his associates decided to work the property as an open pit. The contour of the ground and the sheared and brecciated character of the overburden was favorable for hydraulic mining so a 2¼-mile long ditch was dug from a swamp near the French Hill placer mine and water was brought to the property and delivered to a No. 3 hydraulic giant under a 250-foot head. A few small lenses of chromite were uncovered in the floor of the pit and 2 carloads were shipped in 1948 and one in 1949.

The property was purchased by Norman Johnson of Corvallis, Oregon in June 1951 and the J. and W. Mining Company was formed. In August 1951 twelve men were employed at the property. Chromite was being mined from a lens 4 feet thick which was exposed for a length of 30 feet in the floor of the pit. A Chicago pneumatic diamond drill and two bulldozers were being operated in the search for new ore bodies. About 100 tons of chromite had been shipped to the stockpile at Grants Pass by the new operators.

High Dome (Holiday) mine consists of five claims located in the NW¼ sec. 21, T. 18 N., R. 3 E., H., at the head of the West Fork of Patrick Creek. The property was located by Edward Cook and was leased and operated by C. H. Bennett and J. K. Remsen in 1942. A chromite zone 10 inches to 2 feet wide was exposed for a length of about 40 feet in the wall of a bulldozer cut in serpentine. Shipments totaling 275 long tons averaging 44.6 percent Cr_2O_3 and with a chromium-iron ratio of 2.48 were made to the stockpile at Grants Pass in 1942. In 1948 E. A. Carlson of Smith River. California shipped 3 carloads of ore to Spokane which he said averaged 48 percent Cr_2O_3 and had a chromium-iron ratio of 2.7. Carlson prospected the property with 8 diamond drill holes having an average depth of 40 feet and developed some new ore. In 1951 the property was owned and operated by E. A. Carlson and Leo Dressler of Crescent City. A new road was built to the deposit and camp buildings were erected to accommodate 10 men. Chromite was exposed 2 to 3 feet thick and 6 feet high for a length of 12 feet along a serpentine wall striking N. 10° W. and dipping 60° E. but was cut off by a fault striking N. 72° E. and dipping 50° S. The mine foreman said that chromite had been exposed in the floor of a bulldozer pit which was 130 feet long, 40 feet wide, and 12 feet deep in October 1951 but was covered by a recent slide of ground loosened by a heavy rainfall. Eight men were employed at the property and Carlson said about 200 tons of ore averaging 48.8 percent Cr_2O_3 with a 3.4 chromium-iron average had been shipped to the stockpile at Grants Pass. Equipment included a portable air compressor, rock drills, an Allis Chalmers D-10 bulldozer and an H.D-5 diesel powered tractor loader fitted with a ¾-yard bucket.

High Plateau mine consists of four claims in the NE¼ sec. 28 T. 18 N., R. 2 E., H. The property was first located by H. H. Morrell and John Hester in September 1917.[22] In 1918 it was leased and operated by Adams and Maltby and 1334 long tons of ore were mined from an outcrop which was 16 feet wide in places. The property lay idle from 1918 to 1933 when

[22] Wells, F. G., op. cit., p. 33, 1945.

it was relocated by Eugene Brown of O'Brien, Oregon, the present owner. A large body of high grade, massive chromite was discovered. Two adits with crosscuts, drifts and raises blocked out a tabular mass of solid, high-grade chromite 6 to 16 feet thick, extending 145 feet in a N. 20° W. direction and dipping 22° E. A winze was sunk 40 feet in ore to connect with a raise from the lower adit. The ore body was enclosed in serpentine. The property had a recorded production of 13,180 long tons of ore assaying 50 to 55 percent Cr_2O_3 with a chromium-iron ratio of 2.94 to 3.74 up to August, 1945 when it was closed because of market conditions.

The mine was reopened in July 1951 when the owner gave a group of seven men including Pat and Clarence Strong, Bert Simer, Dick Stewart, Ted Terrel, Ed Knippel and Earl Harader of O'Brien, Oregon a contract to mine the ore on a percentage basis. The property was equipped with a compressor and camp buildings but the miners were required to furnish all materials and supplies. The partners had mined the 2,000 ton maximum amount acceptable under the government purchasing program, by October. The ore was taken from a stope about 24 feet above the lower adit. There are several good blocks of ore remaining in sight and mining will be resumed next season.

Hole in the Ground (Sarina) is in the NE¼ sec. 12 T. 18 N., R. 1 E., H., about 3 miles north of the Stone Corral lookout. The property is owned by Robert Sarina and was reported [23] to be leased to W. B. Barton, Eugene, Oregon and John Johnson of Crescent City in 1951. A new access road was built about 2½ miles long from the Stone Corral-Wimer road to the property and a portable compressor was moved to the site. The road was impassable to cars or trucks due to heavy rains and the property was idle when the area was visited in October 1951.

Judy group (Hicks, Victory No. 2) consists of three claims in sec. 29, T. 18 N., R. 2 E., H., a mile and a half west of the High Plateau mine and is owned by R. I. Hicks of Cave Junction, Oregon. The claims are reached by a very rough access road that can be driven over only in the dry season. The surface of the claims was cleared with a bulldozer and some small bunches of ore were recovered from trenches dug in serpentine. In 1943 the property was leased and operated by the Crescent Pacific Mining Company of San Francisco and 373 long tons of ore averaging 42.68 to 45.20 percent Cr_2O_3 with 2.74 to 2.92 chromium-iron ratio were shipped to the stockpile at Grants Pass, Oregon. The ore was taken from an irregular cigar-shaped lens in serpentine and mined through an inclined shaft dipping 20° E. for a total depth of about 80 feet. The ground was broken by faulting and was hard to support. The property was idle in October 1951.

Mountain View (High Divide, Tyson) is in the E½ sec. 33 and W½ sec. 34, T. 18 N., R. 1 E., H., about 7½ miles east of Smith River. Three patented mining claims described as Mineral Lots 40, 41, and 42 and two unpatented claims are owned by the Tyson Chrome Mines, Ltd. of San Francisco. From 1869 to 1889,[24] chrome ore was shipped from this property around Cape Horn to Baltimore at the rate of 1,500 to 2,000 tons annually. The mine lay idle from 1889 until 1918 when it was operated by the American Exploration and Construction Company, under a lease from the Tyson Estate.[25] Operations ceased at the end of the war in

[23] Engineering and Mining Journal, vol. 152, No. 10, p. 120, 1951.
[24] Crippen, R. A., Jr., op. cit., p. 156, 1950.
[25] Wells, F. G., op. cit., p. 28, 1946.

1918 and the property was idle until the Tyson Chrome Mines, Ltd. purchased the property in 1942.

The new owners drilled three diamond-drill holes 65 to 140 feet deep on the Mountain View No. 3 claim without finding an extension of a lens that was mined from an old, partly caved and filled shaft. The old workings indicated that the lens was from 10 to 15 feet wide, 150 feet long in a N. 68° W. direction and from 20 to 50 feet deep and was enclosed in serpentine. Wells [26] calculated that not more than 8,750 tons of ore had been mined from the deposit. The old shaft was unwatered and sunk an additional 30 feet but no ore was found. A new vertical shaft was started 300 feet N. 63° W. from the old shaft and sunk to a depth of 85 feet. Drifts were driven about 40 feet north at the 47 and 75 foot levels. A lens of chromite 20 feet wide was mined from the 47 foot level and 225 long tons of ore which averaged 42 percent Cr_2O_3 and had a chromium-iron ratio of 2.43 were shipped in 1943. The property was shut down in 1943 when the Tyson Company opened up the ore body at French Hill.

In August 1951, George Wooley of Drain, Oregon obtained a lease on the property from the Tyson Chrome Mines, Ltd. and located 6 additional claims which were prospected with bulldozer cuts. A lens of chromite was uncovered in the floor of a bulldozer trench in the southwest corner of Mineral Lot 41 about 2800 feet in a S. 65° W. direction from the old Mountain View shaft. Thirty-four tons, averaging 44.1 percent Cr_2O_3 with a 2.6 chromium-iron ratio had been shipped to the stockpile at Grants Pass by October. The collar set for a single compartment shaft was located in the floor of the pit and a lens of chromite 12 inches wide striking N. 25° W. and dipping 48° E. Four camp buildings were erected to accommodate a crew.

Muzzle Loader (Stevens No. 1) is in the SE¼ sec. 4, T. 15 N., R. 5 E., H., about 35 miles from Highway 199, via the French Hill-Big Flat road. The claim was located by William and Robert Stevens on May 30, 1942 and was leased and operated by C. H. Bennett and J. K. Remsen in 1942-1943. The lessees built a steep access road 2 miles long from the road at Jones Creek. Chromite occurred as pods and boulders in faulted and broken serpentine. It was mined from a bench having a maximum width of 35 feet and a face about 20 feet high extending about 80 feet in a N. 25° W. direction in the face of the hill. The largest pod was about 40 feet long and from a few inches to 4 feet thick. It was mined partly from the bench and partly from an adit driven east from the south end of the bench. Bennett said that about 150 tons of chromite shipped from the deposit averaged 49.5 percent Cr_2O_3 and had a chromium-iron ratio of 2.96. The property was idle in October 1951.

Old Doc is in sec. 22, T. 15 N., R. 2 E., H., on the east slope of Rattlesnake Mountain. The property was owned and operated by J. E. Inman and his brother in 1943. Chromite occurred in a lens 60 feet long and 6 feet thick trending N. 70° E. and dipping 30° NW. in sheared serpentine. The ore was mined from a bulldozer cut 80 feet long and 50 feet wide in the steep slope of the mountain. The deposit is credited [27] with a production of nearly 1,000 tons of ore containing 37.40 to 47.08 percent Cr_2O_3

[26] Wells. F. G., op. cit., p. 29, 1946.
[27] Wells, F. G., op. cit., p. 70, 1946.

with a chromium-iron ratio of 2.22 to 3.23. The property was idle in October, 1951.

Soldier's Well (McClendon) is in sec. 17, T. 15 N., R. 2 E., H. C. H. McClendon and Arthur Deleray shipped about 70 tons of ore from the property in 1944. Chromite occurred in bands 18 to 24 inches wide in serpentine and was mined from a 35° incline shaft to a depth of 40 feet. The property was idle in 1951.

Toujours Gai (Elk Camp) is in the NW¼ sec. 20, T. 18 N., R. 3 E., H., about 8 miles northwest of the highway at Patrick Creek Tavern. It is owned by Ernest J. Petersen and Louis Harper of Gasquet, California. The claim was located by D. L. Webb, H. T. Borgman and W. J. Stillwell of Kerby, Oregon in August, 1942. It was leased and operated by E. H. Linkhart and F. N. Messenger of Kerby, Oregon in 1943 and 1944. Chromite occurred in serpentine as a flat seam a few inches to 3 feet thick over an area about 75 feet square. It was first mined through an adit driven north about 80 feet; later, it was stripped with a bulldozer and worked as an open pit, when it was found that the ore was covered with only 6 to 8 feet of loose rock and red soil. A second lens of chromite 2 to 6 feet wide striking N. 40° E. and with a dip varying from 70° W. to 75° E. was uncovered in the north bank of the pit. The ore was mined from an adit about 90 feet long. The operators said they shipped about 400 long tons of ore in 1943 and 100 tons in 1944 which averaged almost 50 percent Cr_2O_3 and had a chromium-iron ratio of 3.20.

In July 1945 the property was purchased by L. J. Harper, J. F. Maloney, A. E. Carlson and Hugh Chapman of Seattle, Washington and renamed the Elk Camp mine. Camp buildings were erected to accommodate a crew of 10 to 12 men and machinery and equipment including two portable compressors, an electric generator, centrifugal pump, jackhammers and a portable diamond drill were moved to the site. Ten diamond-drill exploration holes were drilled 45 to 80 feet deep and according to Harper located a ledge of chromite 18 inches thick and 45 feet long about 50 feet beneath the surface. A crosscut from the bottom of an incline shaft sloping 60° E. and 60 feet deep is said to be within 10 feet of this lens. A bulldozer cut in serpentine 175 feet long in a N. 10° E. direction and 12 feet wide and 20 feet deep was stopped within 40 feet of the collar of the shaft. No ore was visible in the cut. The shaft was full of water and the property was idle in October 1951.

Clay

Deposits of clay suitable for brick manufacture occur at several points within a short distance of Crescent City, especially in Elk Valley and along the Smith River.[28] No clay has been mined in Del Norte County in recent years.

Coal

Some thin seams of lignite occur in the underlying formations of the low coastal plain in the vicinity of Crescent City.[29] A vein of tough brown lignite, 4 feet in thickness, is said to have been penetrated by two bore holes three-quarters of a mile apart and 160 feet deep, located about 400 yards inland, opposite Point St. George. These borings were made in 1885 and no further exploration work has been done.

[28] Dietrich, W. F., The clay resources and ceramic industry of California: California Div. Mines Bull. 99, pp. 76-77, 1928.
[29] Laizure, C. McK, Del Norte County: California Min. Bur. Rept. 21, p. 285, 1925.

Copper

Copper was discovered in the Low Divide District in 1853.[30] Mines were opened in 1860 and shipments of highgrade ore were made to smelters in Wales and Germany. Between 1860 and 1863 some 2,000 tons were shipped from the Alta and Union mines. The mining camp of Altaville had several hundred inhabitants at that time. When the price of copper dropped at the end of the Civil War, the mines were shut down and there has been no production from them in recent years.

Copper deposits occur as veins which pinch and swell to form lenses along the strike and dip and are enclosed in serpentine. The principal copper minerals are chalcocite, cuprite, malachite and native copper. Chalcopyrite is found in minor amounts. Gold and silver usually accompany the copper minerals.

Most of the copper prospects mentioned in earlier reports have not produced and have probably been abandoned. Descriptions of mines included in this report have been taken from earlier reports and the references are listed in the table of mines.

Alta (Alta California) consists of lot 38, in sec. 35, T. 18 N., R. 1 E., H. in the Low Divide district and about 9 miles east of Smith River. The property (74.36 acres), was purchased May 17, 1951 by John I. Noce of Gasquet. The Alta mine, one of the first copper mines in California, was worked through a single compartment shaft, 455 feet deep and inclined 63 degrees in a N. 48° E. direction. An adit driven northwestward from an adjoining gulch intersected the shaft at a depth of 112 feet. Levels were driven north and south from the shaft at 96, 162, 228 and 324 feet below the adit level. Ore was stoped from drifts on all except the bottom level and records of shipments to Swansea show returns of $41 to $102 per ton. The mine was shut down in 1867 when the price of copper dropped at the end of the Civil War. In August 1951 a partnership including John Noce, Joe Reinarz and R. E. Yoder were engaged in retimbering the old shaft which was burned out above the adit level. Two cabins were built to accommodate a mine crew and a new timber headframe was erected. A single drum hoist driven by a Chevrolet engine was housed in a new wooden frame building. The shaft had been retimbered for 60 feet on August 28.

Chicago Camp (Del Norte Camp) is near Whiskey Lake about a quarter of a mile east of Sanger Peak in sec. 29, T. 18 N., R. 5 E., H. Maxson [31] states that 178 claims were located and an extensive development program was carried out by a Chicago association in 1917. Five miles of road were built from Waldo, Oregon, and cabins, laboratories, and power equipment were installed on the site. Several tunnels were driven on veins and some lowgrade chalcopyrite-pyrite ore was mined. At the end of the World War I, when the price of copper dropped, exploration ceased.

Cleopatra (Dedrick, Dietrick group) is near Diamond Creek, just south of the Oregon border in sec. 34, T. 18 N., R. 2 E., H. It is owned by Olen Bell of Grants Pass, Oregon. The property was prospected with adits and shallow pits in serpentine and are now caved. It has been idle

---

[30] Maxson, J. H., Economic geology of Del Norte and Siskiyou Counties: California Jour. Mines and Geology, vol. 29, p. 144, 1933.
[31] Maxson, J. H., Economic geology of Del Norte and Siskiyou Counties: California Jour. Mines and Geology, vol. 29, p. 147, 1933.

for many years and the few buildings on the property have collapsed. No ore was seen on the old dumps.

Occidental, in the Low Divide district in sec. 2, T. 17 N., R. 1 E., H., adjoins the Alta mine on the south. The property was opened by an adit 450 feet long which did not reach the vein; a 110-foot shaft which showed 2 feet of ore, and a second shaft 100 feet deep. Some surface samples assayed high in copper. The property has been idle in recent years.

Salt Lake-California (Union) is in the Low Divide district in sec. 35, T. 18 N., R. 1 E., H. According to Laizure [32] the property included eight claims located on the northerly extension of the Alta vein. The principal copper-bearing lode, which strikes north, passes from the Alta California property, through the Union No. 1, 2, and 3 claims and the Mammoth No. 1 claim. On the Union No. 1 claim, two adits 450 and 120 feet long, intersected the ore body. In the first adit, drifts were run along the vein and most of the early production was stoped from them. In the second adit, at a higher elevation than the first, the ore body was explored by 40-foot drifts north and south along the vein. On the Union No. 2 claim, work consisted of an open cut, on Union No. 3, of a shaft 100 feet deep, and on the Mammoth No. 1 claim, of a 400-foot crosscut adit. A vein 4 feet wide on the Bonanza claim was followed for 350 feet but the ore was lower in grade than that of the north-striking vein in the Union No. 1 claim. Lowell [33] states that 400 tons of ore from a winze on the Union No. 1 claim averaged 18 percent copper and $1.50 in gold.

Gold

Most of the gold produced in Del Norte County came from early day placer operations along the Smith River and its tributaries. Gold, usually associated with pyrite and arsenopyrite, has also been found in quartz veins and stringers in greenstone and slate and near the contact with diorite and granodiorite. Some gold and silver was recovered from the copper ores mined in the Low Divide district.

There has been very little activity in gold mining in recent years and many of the properties listed have long been abandoned. The descriptions of the following properties, together with references to them, have been taken from earlier reports.

Big Flat (Oro Grande, Oro Verde) is on the east bank of Hurdy Gurdy Creek, in sec. 1, 12, 13, 14, T. 15 N., R. 2 E., H. Watts [34] reported that a freshet in 1889 greatly damaged the ditch, which conveyed the water a distance of about 9 miles from the upper portion of Hurdy Gurdy Creek to these mines. The property had been operated as a hydraulic mine for 8 years and at one time employed more than 300 men. The mine lay idle for many years until an attempt was made to reopen a portion of the property by the Oro Grande Mines Company in 1945. The water ditch and flume were repaired, and a No. 5 hydraulic giant was placed at a pit having a 20 foot bank of gravel above a blue and gray slate bedrock which dipped flatly into the bank. Four sluice boxes 10 feet long and 3 feet wide were used to trap the gold. The mine was equipped with

[32] Laizure, C. McK, Del Norte County: California Min. Bur. Rept. 21, pp. 289-290, 1925.
[33] Lowell, F. L., Mines and mineral resources of Del Norte County: California Min. Bur. Rept. 14, p. 383, 1914.
[34] Watts, W. L., Del Norte County: California State Min. Bur. Rept. 11, pp. 195-199, 1890.

a blacksmith and machine shop, a portable compressor, a Caterpillar tractor, a P. & H. shovel, and a derrick. A watchman on the property in August, 1945 stated that the mine was idle because of the shortage of miners. In October, 1947 the mine was still idle but the foreman reported that it was operated a short time that spring but had been closed down by the Division of Fish and Game because of the silt it discharged into the river. Assessment work for 1950 was recorded by Lydia Wilke.

French Hill mine is in the French Hill district, sec. 32, 33, T. 17 N., R. 2 E., H. The mine was one of the early placer operations in Del Norte County. According to Logan [35] two pits were worked with hydraulic giants and an ounce of platinum was said to be recovered for each thousand dollars worth of gold. Water was brought from Craigs Creek through 5 miles of ditch and flume and delivered to two No. 2 giants under a 150 foot head. The gravel occurs in a channel 800 to 1,000 feet wide that trends northeastward. In the French Hill pits, the banks were 2 to 4 feet high in one pit and as much as 20 feet high in a second pit to the southwest, which had 2 feet of blue gravel near the bottom. In November 1945, John H. Hopkins of Crescent City purchased 160 acres of the placer mine from C. P. Terwilliger and operated on a small scale by hand shoveling into three lengths of sluice boxes. A shortage of water resulted in only 2 weeks of operations in 1946. The mine has been idle in recent years except for short periods of small scale ground sluicing.

Monumental Consolidated Quartz mine is in sec. 1, T. 18 N., R. 3 E., H. and includes 165 acres of patented land owned by W. V. Stanfield of Wallace, Idaho. Laizure [36] reported that a quartz vein, containing specular hematite and some gold and copper, was developed by a two-compartment vertical shaft, 240 feet deep, and an incline shaft to the 100-foot level. Three-quarters of a mile of drifts were on the 100-foot level; a raise to the surface and a winze also from the 100-foot level; and six prospect drifts 30 to 40 feet long. The property lay idle for many years until 1946 when it was leased to Bud Smith of Cave Junction, Oregon. Smith mined 53 tons of ore from a stope above the 100-foot level and about 40 feet east of the shaft. The vein was about 4 feet wide and the ore shipped to Salt Lake City assayed $15.90 per ton in gold. Because shipping and smelting costs were about $17.00 per ton, the ore was unprofitable to ship before concentrating. The mine has had no production since 1946.

Oak Flat and East Fork groups (Patrick Creek) are on Patrick Creek about 3 miles north of the highway in sec. 33, T. 18 N., R. 3 E., H. This placer property includes 150 acres of patented land owned by Don Raymond and associates. The gravel, about 60 feet wide in places along the creek and about 8 feet deep, is underlain by serpentine bedrock. There are many serpentine and diorite boulders which must be shifted or handled with a windlass before the bedrock can be cleaned. Water, obtained from Nine Mile Creek through 1,200 feet of ditch, is brought to a No. 2 hydraulic giant under a 75-foot head. The gold is caught in 50 feet of 12-inch sluice boxes which are fitted with pole and Hungarian riffles. The gold is coarse and includes a few nuggets. Raymond works alone and intermittently.

---

[35] Logan, C. A., Platinum and allied metals in California: California Min. Bur. Bull. 85, p. 62, 1918.
[36] Laizure, op. cit., pp. 290-291, 1925.

Yates Beach mine [37] is on the beach, one mile south of Crescent City. In the early 1890's. A. L. Yates operated a washing plant on a small scale. Sand was shoveled into wheelbarrows and dumped on the washing machine, which consisted of a table 3 feet by 11 feet from which it flowed over another table 6 feet by 8 feet. The lower end of the table was made of sheet iron punched with $\frac{1}{4}$-inch holes. The clean sand flowed over corrugated plates 6 feet long set at an angle of 14 degrees, and then onto a blanket table having a 4-inch deep quicksilver trap at both ends. Three men were employed to wheel sand and one to operate the tables. Fifty inches of water transported by flume was used. Crawford said that about $5 was taken out for each man employed. An attempt to mine the beach sand on a larger scale in 1913-1914 failed and there has been no beach mining in recent years.

Manganese

The occurrence of manganese has been noted by Ricker [38] and the following descriptions are taken from his report. There has been no development of the deposits.

Siskiyou Fork Trail deposit is in sec. 11, T. 17 N., R. 3 E., H., about 30 miles from the railroad and consists of films of manganese on schist.

Stone deposit is said to be located in sec. 35, T. 18 N., R. 1 E., H., about 17 miles from the railroad. The deposit consists of manganiferous chert and is of low grade.

Miscellaneous Stone

Sand and gravel is mined intermittently from pits along the Smith River and used to build or repair roads or for concrete aggregate. Rock used to build the jetties in Crescent City harbor was obtained from a quarry on Preston Island in 1947 and at Point St. George in 1949.

Basalt Rock Company (Preston Island). Location: About 1 mile west of Crescent City in sec. 30 (?), T. 16 N., R. 1 W., H (projected). The rock is a fine-grained heavy greenstone. In quarying the rock coyote holes were drilled with drifters using a 4-foot burned cut round in a 3- by 4-foot section. One coyote hole was driven 55 feet at a right angle to the face about 120 feet above the toe. Tee drifts were driven 90 feet to the left and 65 feet to the right from the end of the coyote hole. Seven powder pockets along the drifts were loaded with about 12 tons of 60 percent bag powder. About 100,000 tons of rock is estimated to have been broken in blasting two coyote holes. The broken rock was classified as ''A'' rock, rocks weighing 5 to 15 tons; ''B'' rock, rocks weighing 3 to 7 tons; and ''C'' rock, rocks weighing 5 pounds to 4 tons. In building the jetty, the ''C'' rock was placed first, then the ''B'' rock, and finally a covering of ''A'' rock. The ''B''- and ''C''-size rocks were separated and loaded onto Euclid dump trucks with two $2\frac{1}{2}$-cubic yard and one 2-cubic yard Northwest shovels. The ''A'' size rock was handled by a Northwest shovel which was converted into a crane. Some rocks were handled with slings alone but usually steel pins 2 inches in diameter and 10 inches long were placed in jackhammer-drilled holes to hold the crane slings. From 3,000 to 3,500 tons of rock were moved in two 10-hour shifts

[37] Crawford, J. J., Gold—Del Norte and El Dorado Counties: California Min. Bur. Rept. 12, pp. 100-101, 1894.

[38] Ricker, Spangler, Manganese in California, Del Norte County: California Div. Mines Bull. 152, pp. 50-51, 1950.

each day. About 115 men were employed from July to October 1947, when the work was closed down for the season. The property was idle in 1951.

Crescent City Rock and Sand Company is on the west bank of Smith River in sec. 11, T. 17 N., R. 1 W., H. The property is owned by Presly Tryon of Fort Dick. The pit was equipped with a portable crushing and screening plant. The gravel was dug about 4 feet deep with a bulldozer which pushed the loose material into the steel hopper of a portable screening and crushing plant. The material was drawn from a hopper onto a conveyor belt which discharged it onto a double-deck vibrating screen fitted with 1½-inch and ¾-inch screens. Plus 1½-inch gravel was discharged to a 20- by 19-inch jaw crusher set to crush to ¾ inch. Material remaining on the ¾-inch screen was crushed to minus ¾ inch by a pair of 20- by 36-inch rolls. The minus ¾-inch product, used for road work, was stockpiled and loaded into dump trucks for deliveries. Five men were employed at the plant in October 1947. The pit was idle in October 1951.

Point St. George deposit (Macco-Morrison-Knudson Company Inc.) is at Point St. George about 4 miles northwest of Crescent City and is on land owned by the McNamara estate and leased to Del Norte County. The Morrison-Macco-Knudson Company, Inc. had a contract with the U. S. Army Engineers to quarry and place 575,000 tons of rock on the west jetty in Crescent City harbor. The rock in the quarry includes a fine-grained tan-colored sandstone and a dense dark gray-colored volcanic rock which lies above a dark gray shale. The quarry face stands about 170 feet above the sea and the rock is broken by driving coyote drifts into the face, loading them with bags of black powder and blasting. Powder consumption averaged about three-fourths of a pound of powder per ton of broken rock. The rock was shovel-sorted into three sizes: rocks weighing 7 tons and over; rocks weighing 3 to 7 tons; and rocks weighing 5 pounds to 3 tons. Material was loaded into twelve 15-ton capacity Euclid trucks by power shovels and cranes using slings or a net. The season for placing rock was from May 1 to October 15 and about 60 men were employed on a ten hour shift. The quarry was idle in October 1951.

Quicksilver

According to Ransome,[39] the quicksilver deposits in Del Norte County have been known since the early 1850's, when the first placer miners in the region mined cinnabar and produced quicksilver for use in amalgamation. The deposits have been worked intermittently for short periods when the price of quicksilver was high but the production has been small. The only output reported in recent years has come from the Webb mine on Patrick Creek. Descriptions of the Big Boy and Sunny Brook mine are taken from earlier reports, references to which are included in the table of mines.

Big Boy Cinnabar group is in sec. 36, T. 19 N., R. 2 E., H. on the California-Oregon State line, about 4 miles northeast of the Sunny Brook mine, and about 10 miles west of Monumental. The original location was made by John Griffin sometime after World War I. Cinnabar occurs as small fissure fillings in a large mass of altered diorite. Griffin attempted

[39] Ransome, A. L., and Kellogg, J. L., Quicksilver resources of California: California Jour. Mines and Geology, vol. 35, pp. 375-376, 1939.

to concentrate the ore in a sluice box and to treat the concentrates in two 4-inch pipe retorts. The arrangement was not successful, and at a later date the J. I. L. Dredging Company of Spokane leased the property. Concentration by sluicing was again tried, and again proved very inefficient. Since 1933, there has been no recorded activity at the property.

Sunnybrook (Riamond Creek) prospect is[40] in the NW¼ sec. 11, T. 18 N., R. 2 E., H., about 18 miles by road west of Monumental and 4 miles southwest of the Big Boy group. Small stringers of cinnabar occur in veins of quartz enclosed serpentine; in places cinnabar is found in fissures within the serpentine. The original discovery of cinnabar in the county was made at this location in 1850. The claims were relocated by the Diamond Creek Cinnabar Company in 1916 and in 1917, one flask of quicksilver was produced with a 3-pipe, Johnson-McKay retort. There has been no recorded production since that date.

Webb (Patrick Creek, Shults Bros., Wilmot). Eight claims are in the SE¼ sec. 20, T. 18 N., R. 3 E., H. The property was located by Dave Webb of Kerby, Oregon and it has been operated since by a number of lessees. In July 1942 H. C. Wilmot of Sutherlin, Oregon built a road to the property from the Patrick Creek road and drove an adit S. 1° W. for 40 feet into the hill. The first 12 feet cut through a yellow- and tan-colored meta-andesite lying above a fine-grained bluish-gray trap rock. At a distance of 35 feet, a fine-grained gray dike 3 feet wide, strikes N. 70° W. and dips 80° N.; a dark gray peridotite underlies the dike. Native quicksilver and cinnabar occur in vugs and seams in the hard gray trap rock and in seams in the meta-andesite above the dike. Native quicksilver was plentiful. At 35 feet from the portal, a drift was driven west for 40 feet, then offset about 6 feet south to the peridotite and continued for 25 feet along the peridotite footwall in a S. 65° W. direction. The fine-grained gray rock in the drift contained some cinnabar. A crosscut driven 25 feet northeast from the drift at the offset is in waste.

A 4- by 6-foot vertical shaft 35 feet deep was sunk at a point about 10 feet north and 5 feet west of the portal of the adit. A crosscut was driven south for 35 feet from the bottom of the shaft, thence S. 60° W. for 15 feet to ore and continued in ore for 20 feet. A second adit was driven toward this ore from a point about 100 feet northeast and 35 feet lower than the collar of the shaft. This adit will eliminate the pumping and hoisting necessary in working through the shaft.

Bert Avery operated the property in 1943 and shipped some sorted ore to the Mountain King mine at Gold Hill, Oregon for treatment. He said the ore assayed about 20 pounds of quicksilver per ton. Avery installed two steel pipe retorts to treat some of the ore piled on the dump from development work but the operation was not successful. The clay in the ore, according to Avery, formed a crust on top of the charge in the retort and there was considerable loss of quicksilver by leakage.

In 1944 and 1945, Ed and Oscar Hanna leased and operated the operated the property. They built a new 4-pipe retort and treated some high grade ore that they mined in a shaft on the hill about 200 feet southwest and 75 feet higher than the shaft sunk at the portal of the discovery adit. In October 1946 the machinery and lease were purchased by I. N. and M. D. Shults of Medford, Oregon.

[40] Ransome, op. cit., pp. 375-376, 1939.

The Shults brothers mined the ore in the discovery adit from an open cut and installed a Lacey rotary furnace purchased from the Mirabel mine in Lake County. The furnace is 30 inches in diameter and 30 feet long and has a rated capacity of 25 tons per day. It is fired with fuel oil. The mercury vapor and furnace gases are drawn through the furnace by an American blower and through an 8- by 8-inch Sirocco dust collector to ten steel condenser pipes 16 inches in diameter and 24 feet long. The gases from the condensers are passed through a wooden tank 8 feet in diameter and 8 feet high to collect the soot. Houses were built to accommodate a crew of 10 to 15 men. There was a small production reported from this property in 1948 but the price of quicksilver made the operation uneconomic and the mine and plant have been idle since then, with the exception of a few months operation by Byron P. Harmon of Roseburg, Oregon in 1951. The property was idle in October 1951 but the equipment appeared to be intact.

BIBLIOGRAPHY

Allen, John E., Geological investigation of the chromite deposits of California: California Div. Mines Rept. 37, pp. 101-167, 1941.

Aubury, Lewis E., The quicksilver resources of California: California Min. Bur. Bull. 27, 273 pp., 1903.

Bradley, W. W., Quicksilver resources of California: California Min. Bur. Bull. 78, 389 pp., 1918.

Coy, Owen D., California county boundaries, California Historical Survey Commission, Berkeley, 1923.

Crawford, J. J., California Min. Bur. Rept. 12, pp. 541, 1894. . . . California Min. Bur. Rept. 13, pp. 499-502, 1896.

Crippen, R. A., Jr., Mineral commodities of California, Chromite: California Div. Mines Bull. 156, pp. 294-298, 1950.

Dietrich, Waldemar F., The clay resources and ceramic industry of California: California Div. Mines and Mining Bull. 99, 383 pp., 1928.

Diller, J. S., Topographic development of the Klamath Mountains: U. S. Geol. Survey Bull. 196, pp. 31-35, 1902.

Diller, J. S., and Kay, G. F., U. S. Geol. Survey Geol. Atlas, Riddle folio (No. 218), 1924.

Engineering and Mining Journal, vol. 152, no. 10, 1951.

Eric, John H., Tabulation of copper deposits of California: California Div. Mines Bull. 144, 429 pp., 1948.

Haley, Charles Scott, Gold placers of California: California Min. Bur. Bull. 92, 167 pp., 1923.

Hershey, O. H., Del Norte County geology: Min. and Sci. Press, vol. 102, p. 468, 1911.

Jenkins, O. P., Geologic map of California, scale 1:500,000: California Div. Mines, 1938.

Laizure, C. McK, San Francisco field division, Del Norte County: California Min. Bur. Rept. 21, pp. 281-294, 1925.

Logan, C. A., Platinum and allied metals in California: California Min. Bur. Bull. 85, 120 pp., 1919.

Lowell, F. L., Mines and mineral resources of Del Norte County: California Min. Bur. Rept. 14, pp. 373-390, 1914.

McGregor, Alexander, Del Norte County: California Min. Bur. Rept. 10, pp. 166-168, 1890.

Maxson, J. H., Economic geology of Del Norte and Siskiyou Counties: California Div. Mines Rept. 29, pp. 123-160, 1933.

O'Brien, J. C., Strategic minerals, Redding district: California Div. Mines Rept. 39, pp. 77-84, 323, 330, 1943. . . . Current and recent mining activities in the Redding District: California Jour. Mines and Geology, vol. 44, pp. 335-378, 1948.

Preston, E. B., California Min. Bur. Rept. 10, pp. 795-802, 1890.

Ransome, A. L., and Kellogg, J. L., Quicksilver resources of California: California Div. Mines Rept. 35, pp. 353-486, 1939.

Ricker, Spangler, Manganese in California, Del Norte County: California Div. Mines Bull. 152, pp. 50-51, 1950.

Sanborn, W. C., and Ricker, Spangler, Investigation of French Hill chromite mine, Del Norte County: U. S. Bur. Mines Rept. Inv. 4365, pp. 1-9, 1948.

Watts, W. L., Del Norte County: California Min. Bur. Rept. 11, pp. 195-199, 1890.

Wells, F. G., Topographic map of Del Norte County, California, showing distribution of peridotite and location of chromite deposits: California Div. Mines Bull. 134, pt. 1, pl. 1, 1946.

Wells, F. G., Cater, F. W., Jr., and Rynearson, G. A., Chromite deposits of Del Norte County, California: California Div. Mines Bull. 134, pt. 1, chap. 1, pp. 76, 1946.

Wells, F. G., and Hotz, P. E., Mesozoic volcanic series in southwest Oregon: (abstract) Geol. Soc. America Bull., vol. 52, pt. 2, pp. 1937-1938, 1941.

TABULATED LIST OF DEL NORTE COUNTY MINERAL DEPOSITS

Del Norte County mineral deposits are listed in alphabetical order by commodity in the following table. The number in the first column refers to the map, plate 13, in pocket.

References given in the last column refer to the bibliography accompanying this report. Only the last name of the author is given. The first number after each name is the abbreviated date of publication as given in the bibliography; the second number, that following the colon, is the page reference.

BLACK SANDS

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Smith River basin and beach sands south of Crescent City						Gold, platinum and chromite occur in the black sand but no commercially sucessful process has been developed to extract these metals. (Haley 23:83-85; Laizure 25:284-285; Logan 19:55-64; Lowell 14:375-379; Maxson 33:143: herein)

CHROMITE

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Alyce & Blue Jay	L. J. Harper	23	18N	5E	H	Produced 40 tons of 49 percent chromite in World War I. Idle. (Wells 46:73-74)
	Angela		NW¼ 17	17N	2E	H	Two or 3 small pods of chromite in serpentinized dunite; 4 small open cuts. Idle. (Allen 41:119; Wells 46:46)
	Apex (Goose Egg)		8	16N	3E	H	Massive and disseminated chromite in a shear zone in serpentine developed by two shafts and a short adit; 10 tons assayed 37.60 Cr_2O_3 with a 2.40 chromium-iron ratio. Idle. (Wells 46:57-58)

1	Big Dipper (Camp 7, Rowan)		SW¼ 7	16N	3E	H	Three open pits yielded 115 tons in 1943; assayed 42.7 to 43.54 percent Cr_2O_3 with a 2.49 to 2.62 chromium-iron ratio. Idle. (Allen 41-121; O'Brien 43:77, 323; Wells 46:58; herein)
	Big Five (Inman No. 5)	Inman Brothers	NE¼ 27	15N	2E	H	Shipped 700 tons to December 1944; massive chromite in sheared dunite. Assayed 44.03 to 49.62 Cr_2O_3 with 2.41 to 2.96 chromium-iron ratio. Idle. (Wells 46:69-70)
	Big Red Mountain group (Red Mountain No. 1, to 7)	Ben Baker and Fayette Bristol, Rogue River, Oregon	13, 24 SW¼ 18, 19	13N 13N	2E 3E	H H	Small pods and disseminated high-grade chromite in dunite; 72 tons packed out during World War I; several promising outcrops remain; a few tons of ore on dumps. Idle. (Wells 46:71-72)
	Big Buck claim	Inman Brothers	NW¼ 22	15N	2E	H	A small lens of nearly pure chromite mined from a bulldozer cut. Idle. (Wells 46:70)
2	Billy Boy (Hawkins, Divide)		29	16N	2E	H	200 tons of chromite mined from bulldozer cuts in 1943. Idle. (Allen 41:120-121; Wells 46:65-66; herein)
	Blackjack		NW¼-SW¼ 17	17N	2E	H	Chromite was mined from a shear zone in serpentine during World War I. Idle. (Allen 41:119; Wells 46:46)
	Black Prince		24, 35	18N	1E	H	No production recorded. (Wells 46:24)
3	Bluebird (High Point)	E. G. Tarbell, Cave City, Oregon	29	18N	2E	H	Three lenses in landslides yielded 75 tons to August 1944; assayed 41.83-47.73 Cr_2O_3 with chromium-iron ratio 2.552-2.959. Idle. (Wells 46:38-39; herein)
	Blue Jay						See Alyce
4	Bonanza	Delbert O'Brien and Donald F. Johnson, O'Brien, Oregon	21	18N	2E	H	Lumps, bunches, and stringers of chromite were mined from a shear zone in serpentine; 149 tons shipped in 1942 averaged 50.5 percent Cr_2O_3 with a chromium-iron ratio of 2.82. (O'Brien 43:77; Wells 46:37; herein)
	Camp 7						See Big Dipper

CHROMITE—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
5	Camp 8 (St. Patrick)		E½ 19	16N	3E	H	Developed by 4 adits now caved; yielded 100 tons of ore in 1918; 27 tons shipped in 1942, assayed 40.4 percent Cr_2O_3 with a chromium-iron ratio of 2.35. (Allen 41:122-123; O'Brien 43:77; Wells 46:59-60 herein)
	Carla	C. Stevens, J. Wilson	9	15N	2E	H	Shipped 28 tons of ore in 1944; assayed 38 to 45 percent Cr_2O_3 with a 2.2 to 2.8 chromium-iron ratio. Idle. (Wells 46:67)
6	Chrome Hill No. 1 (Theone, Hance & Webb)	Donald Raymond, Gasquet leased to E. A. Carlson	29	18N	3E	H	Twenty tons of ore mined from an adit and open cuts; narrow stringers. Active, see text. (O'Brien 43:324; Wells 46:45; herein)
	Contact		29	16N	2E	H	Three tons of ore mined and piled beside two shallow pits. (Wells 46:24 & 66)
	Cooncan		12	16N	2E	H	A lens of chromite 5 to 10 inches wide exposed for a length of 8 feet; some heavy float boulders; below a cliff. Idle. (Allen 41:121-122; Wells 46:55)
	Coon Creek No. 1		12	16N	2E	H	Banded and disseminated chromite in dunite mined from an inclined shaft 40 feet deep and from surface cuts. Idle. (O'Brien 43:323; Wells 46:55)
	Coon Mountain group		11	16N	2E	H	Twelve tons shipped in 1943 from a cut in a narrow shear zone in saxonite. Idle. (Wells 46:53-55)
7	Copper Creek (Low Divide, Rowdy Creek)		Lot 39 in SW¼ 26	18N	1E	H	Three large ore bodies were mined from a glory hole and stopes; ore averaged 38 to 45 percent Cr_2O_3 with a chromium-iron ratio 2.5-1. Idle. (Bradley 18:125-128; Crawford 96:48; Laizure 25:28a; Lowell 14:380; Maxson 33:156; O'Brien 43:323; Wells 46:21, 27-28; herein)

	Crescent		27	15N	2E	H	Some ore was mined from a bulldozer cut 50 feet long; no ore in sight. Idle. (Wells 46:69)
	Crescent City beach deposits		34, 2, 11	16N 15N	1W 1W	H H	Concentrations of beach sands south of Crescent City carried 4 to 11 percent Cr_2O_3; percentage of ilmenite and magnetite is high. No production reported. Idle. (Wells 46:75-76)
	Cuneo (Inman No. 1)		Middle 16	15N	2E	H	Ore mined from this deposit in 1943 assayed 38.03 to 39.85 percent Cr_2O_3 with a chromium-iron ratio of 2.24 to 2.33. Idle. (Wells 46:68)
	Darnell						See Sunset
	Deleray & Rodgers		SW¼ 16	15N	2E	H	Massive chromite some with veinlets of dunite mined from two trenches; 40 tons assayed 40.04 Cr_2O_3. Idle. (Wells 46:68)
8	Dipper Extension claim	Ted Terrel, O'Brien, Oregon	28	18N	2W	H	About 10 tons of chromite mined from cuts. Idle. (O'Brien 43:323; herein)
	Divide						See Billy Boy
	Ebon		17	18N	5E	H	Eggers reported that he shipped 5 tons of 48 percent chromite ore in 1943. Idle. (Wells 46:73)
9	Eggers chrome claim		29	18N	3E	H	About 30 tons of chromite recovered from surface cuts. Idle. (O'Brien 43:323)
	Elk Camp						See Toujours Gai
	Fairview		W½ 30	17N	2E	H	Bands of low grade chromite exposed in 4 cuts and an adit. Idle. (Allen 41:118; Wells 46:25, 47)

CHROMITE—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
10	Fourth of July	C. H. McClendon, Crescent City	29	16N	2E	H	Massive and disseminated chromite mined from pods in serpentine. 101 tons shipped in 1944 assayed 37.11 to 38.21 percent Cr_2O_3 with a 2.15 chromium-iron ratio. Idle. (Wells 46:65; herein)
11	French Hill (Tyson, J. & W.)	J. & W. Mining Co., Corvallis, Oregon	Lot 37 NE¼ 6	16N	2E	H	Seven lens of chromite mined from June 1942 to August 1946 yielded about 20,000 tons of ore averaging 44 percent Cr_2O_3 with a chromium-iron ratio of 2.5 to 1. Active. See text. (Aubury 06:268; Bradley 18:127-128; Crawford 94:36; 96:48; Laizure 25:286; Lowell 14:380; Maxson 33:154-155; McGregor 90:167; O'Brien 43:78, 324; 48:337; Wells 46:47-52)
	Friday prospect (Bonanza)		21, 28	18N	2E	H	An outcrop of chromite 6 by 6 feet. (Bradley 18:130; Laizure 25:286) Idle.
	Gilmore		30, 17	16N 15N	3E 2E	H H	Some ore shipped from an inclined cut in 1943. Idle. (Wells 46:61, 25, 22)
	Gooch		NW¼ 1	17N	1E	H	Old shaft and adit are caved. No production recorded; no chromite showing. Idle. (Wells 46:32)
	Goose Egg						See Apex
	Goose Creek		22	15N	2E	H	No production recorded. Idle. (Wells 46:70-71)
	Gordon Mountain group						See Zinc Saddle
	Grumpy		30	16N	3E	H	About 150 tons of chromite shipped from bulldozer cuts and two short adits in 1942. Idle. (Wells 46:61)
	Hance & Webb						See Chrome Hill No. 1

	Hawkins						See Billy Boy
	Hawkins Deposit		21	18N	2E	H	One mile west of Friday claim; an outcrop of good chromite shows 30 feet wide for a length of 100 feet. (Bradley 18:130; Laizure 25:286) Idle
12	High Dome (Holiday)	E. A. Carlson and Leon Dressler, Crescent City	NW¼ 21	18N	3E	H	A lens 1-4 ft. thick yielded 275 tons of ore averaging 44.6 percent Cr_2O_3 and with a chromium-iron ratio of 2.48. Active, see text. (O'Brien 43:78; Wells 46:43-45)
13	High Plateau	Eugene Brown	NE¼ 28	18N	2E	H	(Allen 41:117-118; Bradley 18:130-131; Laizure 25:286; Maxson 33:115-156; O'Brien 43:78 & 324; Wells 46:33-37; herein)
	High Point						See Bluebird
14	Hole in the Ground (Sarina)	Robert Sarina	NE¼ 12	18N	1E	H	Al Falkins shipped 43.13 tons of ore in 1942; averaged 39.9 percent Cr_2O_3 with a chromium-iron ratio of 2.61. (Wells 46:32; herein)
	Holiday						See High Dome
	Inman No. 1						See Cunco
	Inman No. 2		21	15N	2E	H	A small tonnage produced from a bulldozer cut in serpentine. Idle. (Wells 46:69)
	Inman No. 5						See Big Five
15	Judy group (Hicks, Victory, No. 2)	R. I. Hicks, Cave Junction, Ore.	29	18N	2E	H	The Crescent Pacific Mining Co. shipped 373 tons of ore to 1943; averaged 42.68 to 45.20 Cr_2O_3 with a chromium-iron ratio of 2.74 to 2.92. (O'Brien 43:324; Wells 46:37-38; herein)
	Logan		17	18N	3E	H	Nine tons of chromite shipped to Metals Reserve stockpile at Grants Pass in 1943. Idle. (Wells 46:41)

CHROMITE—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Lone Grave No. 1 and 2	William Stevens & R. R. Stevens	32 NW¼ 33	16N 16N	3E 3E	H H	High-grade stringers and small pods of massive chromite enclosed in disseminated ore. (Wells 46:61-62)
	Low Divide						See Copper Creek
	Lucky Lode		16	15N	2E	H	A small production in 1943 was included with Rattlesnake Mountain ore. Idle. (Wells 46:22-25)
	Long Hike						See High Plateau
	Low Divide						See Copper Creek
	Malpas prospect						Adjoins Tyson property on the west. Idle. (Bradley 18:131)
	Margy		SE¼ 30	17N	2E	H	A small amount of low grade chromite taken. (Allen 41:118; Wells 46:47)
	McClendon						See Soldiers Well
	Midnight		15	15N	2E	H	No production recorded. (Wells 46:70-71)
16	Mountain View (Tyson, High Divide)	Tyson Chrome Mines, Ltd., Leased to George Wooley	Lots 40, 41, 42 E½ 33 W½ 34	18N	1E	H	Herein. (Aubury 06:268; Bradley 18:124-126; Lowell 14:380; Maxson 33:156; McGregor 90:167; O'Brien 43:78, 324; Wells 46:28-31)
	Mud Spring		33	15N	2E	H	A small shipment is recorded. Idle. (Wells 46:25)
17	Muzzle Loader (Stevens)		SE¼ 4	15N	3E	H	Tabular pods of chromite in dunite were mined by open cut and adits; 169 tons produced in 1943. Idle. (O'Brien 43:78; 324; Wells 46:63; herein)

	Niggerhead		SW¼ 17	17N	2E	H	Several small open cuts expose small amounts of chromite in a sheared talcose zone. Idle. (Allen 41:118-119; Wells 46:45-46)
18	Old Doe		22	15N	2E	H	A lens of chromite 60 feet long and 4 to 6 feet thick in sheared serpentine; nearly 1,000 tons containing 37.40 to 47.08 Cr_2O_3 with a chromium-iron ratio of 2.22 to 3. 23 shipped to December 31, 1944. Idle. (Wells 46:70; herein)
	One Eyed Jack Nos. 1, 2 and 3 (Zoar)		35	18N	1E	H	Narrow stringers and small bunches of chromite in serpentine; about 50 tons of 54 percent ore mined in World War I. Idle. (Maxson 33:156; Wells 46:31)
	Owl Claim		6?	16N	2E	H	Adjoins the French Hill claim on the north; no production recorded. Idle. (Bradley 18:129; Laizure 25:286)
	Patterson No. 1		18	16N	3E	H	Chromite was mined from an adit and trenches; 150 tons produced 1941-1943. Idle. (Wells 46:59)
	Pigeon Roost Spring		21	15N	2E	H	About 15 tons of chromite were mined from a surface trench 35 feet long. Idle. (Wells 46:69)
	Pine Flat		6	18N	2E	H	A small production is recorded. Idle. (Wells 46:25)
	Rattlesnake		17	15N	2E	H	A shipment of 47.32 tons assayed 37.31 to 44.53 percent Cr_2O_3 with a chromium-iron ratio of 2.13 to 2.43. Idle. (Wells 46:67)
	Richey		5	18N	3E	H	Thirteen tons of float ore shipped in 1943 assayed 39.5 percent Cr_2O_3 with a chromium-iron ratio of 2.42. Mined through two adits and a glory hole. Idle. (Wells 46:41)
	Rowan						See Big Dipper
	Rowdy Creek Mine						See Copper Creek

CHROMITE—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	St. Patrick						See Camp 8
	Section Sixteen	Hammond Lumber Co.	SW¼ SW¼ 16	15N	2E	H	R. D. Adams mined a flat tabular deposit from an incline shaft during World War I. Idle. (Allen 41:119-120; Wells 46:67-68)
	Skyline		SE¼ 30	18N	2E	H	Massive and disseminated chromite in a lens of dunite 200 feet long; 165 tons shipped to October 31, 1944 averaged 44.35 to 50.55 Cr_2O_3 with a chromium-iron ratio of 2.73 to 3.52. (Wells 46:39)
19	Soldier's Well (McClendon)		SE¼ 17	15N	2E	H	Three north-striking lenses mined in World War I. Idle. (Allen 41:119-120; Wells 46:69; herein)
	Sourpuss		16	15N	2E	H	A small production is recorded and included with Rattlesnake Mountain shipments. Idle. (Wells 46:26)
	Star and Rough and Ready		31	17N	2E	H	A small production of float chromite was taken from prospect pits. (Wells 46:26, 52)
	Stevens No. 2	Wm. Stevens, R. Stevens	E½SW¼ 28	16N	3E	H	Small pods of high-grade ore in a shear zone in dunite. (Wells 46:62)
	Stevens No. 6	Wm. Stevens	NE¼ 32	16N	3E	H	A small production reported. Idle. (Wells 46:26)
	Sunrise	Edgar E. Gilmore	S½ 19	16N	3E	H	A production of 568 tons during 1941-1952 averaged 50.5 percent Cr_2O_3 with a chromium-iron ratio of 2.82. Ore has been mined in serpentine to a depth of 70 feet from a series of lenses. Idle since July, 1944. (Wells 46:60-61)

	Sunset (Darnell)		SW¼ 5	16N	3E	H	Produced about 379 tons of chromite from open cut and an incline shaft 25 feet deep. Ore occurred in kidneys in a shear zone in serpentine. Idle. (Wells 46:57)
	Tangerine	L. J. Harper, Gasquet	NW¼ 18	18N	3E	H	Small patches of ore found in dunite; 11 tons shipped in 1943. (Wells 46:43)
	Theone Chrome Co.						See Chrome Hill No. 1
	Thursday Evening	C. H. Bennett	SE¼ 7	16N	3E	H	A small production is recorded. Idle. (Wells 46:26)
20	Toujours Gai (Elk Camp)	Ernest J. Petersen & Louis Harper, Gasquet	NW¼ 20	18N	3E	H	Chromite was mined from a flat blanket deposit in serpentine; mined by stripping and through adits; 264 tons shipped to end of 1943 assayed 45-51 percent Cr_2O_3 with a chromium-iron ratio of 2.52 to 3.20. Idle. (O'Brien 43:324; Wells 46:43; herein)
	Tyson Chrome Mines, Ltd.						See French Hill, Mountain View, High Divide
	Victory No. 2						See Judy group
	White Feather		SE¼ 4	17N	5E	H	An irregular pod of massive chromite 30 feet long, 8 feet wide, and 4 feet thick was mined. No other ore was found. Idle. (Maxson 33:153-154; Wells 46:73)
	Zinc Saddle (Gordon Mountain group)	Oscar J. Christensen and H. L. Germaine	SW¼ 25	17N	2E	H	Yielded 179 tons in World War I; no ore developed by bulldozing trenches. Idle. (Allen 41:120; Maxson 33:154; Wells 46:53)
	Zoar						See One-Eyed Jack, Nos. 1, 2 and 3.

CLAY

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Musick	Benjamin Howland, Crescent City					A deposit of yellow plastic clay is located 0.3 miles north of Elk Valley road from a point 4.5 miles from the center of Crescent City. Idle. (Dietrich 28:77; Lowell 14:379-380)
	Turner	George Turner					An undeveloped deposit of pottery clay in Elk Valley. Idle. (Dietrich 28:76-77; Lowell 14:379-380)

COAL

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Point St. George						At Point St. George, a vein of tough brown lignite 4 feet thick was penetrated by two bore-holes 160 feet deep and three-quarters of a mile apart. No commercial value. Idle. (Crawford 94:50; 96:52; Lowell 14:380; Watt 92:198; herein)

COPPER

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Alameda		11	18N	3E	H	Chalcopyrite and gold; short adits in diorite. (Aubury 05:115; 08:139)
21	Alta (Alta California)	John I. Noce, Gasquet,	35	18N	1E	H	Copper oxides in serpentine, 455-foot incline shaft; five levels; shipped high-grade ore to foreign smelters prior to 1867; (Aubury 95:115; 08:139; Crawford 96:58; Eric 48:225; Ireland 93:198; Laizure 25:287; McGregor 90:167; herein)
	Anderson		11	18N	3E	H	Chalcopyrite and pyrite on contact between Patrick greenstone and Galice shale; four short adits; idle. (Maxson 33:147; Eric 48:225)
	Atlantic-Pacific						See Superior
	Aurora (Copper Hill)		36	16N	2E	H	Rich copper oxide float; 6-foot vein; copper and iron sulphides; 70-foot shaft. Serpentine country rock. Idle. (Aubury 05:114; Crawford 96:58; Eric 48:225)
	Aurora Extension		36	16N	2E	H	Shallow surface work exposes a 6-foot vein carrying carbonate and black oxide of copper. Idle. (Crawford 96:58)
	James Bagley		Hanscom Camp, Low Divide Dist. 35?	18N	1E	H	Big outcrop of iron and sulphides; two claims; 450-foot tunnel; caved shaft. Idle. (Aubury 08:138)
	Bears Nest		36	19N	2E	H	A long adit on a 9-foot vein of pyrrhotite with some copper, gold, silver. (Aubury 05:115; 08:138). Idle.
	Britton		9	18N	3E	H	Three adits, one 340 feet; drifts, 120 feet; winze 60 feet on a 9-foot vein in schist and diorite, idle. (Lowell 14:385; Maxson 33:147)
	Call group		11	18N	3E	H	Two claims; irregular bodies of pyrrhotite and chalcopyrite in serpentine carrying some gold; developed by tunnels and shafts. Idle. (Aubury 05:115; 08:139; Eric 48:224)

COPPER—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
22	Chicago Camp (Del Norte Camp)	K. J. Khoeery	29	18N	5E	H	Chalcopyrite and pyrite; extensively developed 1917-1918 but not an impressive showing; reported to have revealed a large orebody at 300 feet; serpentine and diorite country rock. Idle. (Maxson 33:147; Eric 48:225)
23	Cleopatra (Dedrick, Dietrick group)	Olen Bell, 215 South 7th St., Grants Pass, Oregon	3, 4	18N	2E	H	Several narrow veins in serpentine associated with diorite dikes; several hundred feet of underground workings; low grade pyritic type ore showing. Idle. (Eric 48:225; Lowell 14:384; Maxson 33:148)
	Condon						Thirty-eight miles east of Crescent City in Big Flat District. Idle. (Crawford 96:58; Ireland 93:198; McGregor, Alexander 90:167; Watts 92:198)
	Copper Hill group	Chas. Chisman	35	18N	1E	H	High-grade sulphides, oxides, and carbonate (Aubury 05:114) Idle.
	Crescent						In Bald Hills district; 12 miles northeast of Crescent City. A vein 1-4 feet wide; adit on vein 150 feet long; incline shaft 75 feet deep. Idle. (McGregor, Alexander 90:167-168)
	Del Norte	Carlton Bosch, Smith River (1944)	19	17N	2E	H	Little development; good ore found; sulphides with some magnetic iron. Idle. (Aubury 05:116; 08:139; Eric 48:225)
	Del Norte Camp						See Chicago Camp
	Dedrick						See Cleopatra
	Dietrick group						See Cleopatra

Doctor Rock		12	13N	3E	H	Shaft 10 feet deep; adit 30 feet on a quartz vein carrying chalcopyrite and gold; serpentine shale contact; 16 miles of trail to mine. Idle. (Aubury 05:116; 08:139; Eric 48:226; Laizure 25:287; Lowell 14:386)
Edwards		31	17N	2E	H	Some rich chalcocite with gold and silver. Short adit. Idle. (Eric 48:226; Lowell 14:386)
Eva		16	18N	3E	H	Tunnel, shaft, and open cuts; sulphides with quartz. Idle. (Aubury 05:115; 08:139; Eric 48:226)
Express		26, 35	18N	1E	H	One claim northest of the Alta mine. Idle. (Aubury 05:114; Eric 48:226)
Five Diamonds		11	18N	2E	H	Five claims on Diamond Creek. Idle. (Aubury 05:115; 08:138; Eric 48:225)
Flag		23	18N	3E	H	
French Hill		31	16N	2E	H	Pyrite and chalcopyrite associated with Patrick greenstone. Idle. (Eric 48:226; Maxson 33:147)
Hendrix & Howe		------	------	------	------	Five claims located in French Hill district in 1911. (Lowell 14:385) Idle.
Higgins Mountain		25	17N	3E	H	Five claims; open cuts on oxidized outcrops of veins in serpentine. (Aubury 05:116; Eric 48:226; Maxson 33:147) Idle.
Hunters Luck		1	18N	3E	H	Malachite, bornite and chalcopyrite in vein 1- to 8-feet wide on serpentine-porphyry contact; developed in 120 and 160 foot adits. Idle. (Eric 48:226; Laizure 25:288; Lowell 14:384-385)
Idora		35?	18N	1E	H	A 30-foot incline shaft on vein 3-feet wide; vein is stripped for 300 feet. Idle. (Eric 48:226; Lowell 14:384)
Keystone		32	19N	2E	H	Copper glance, red and black oxides, carbonates, and native copper in serpentine; 5-tons of high-grade ore shipped from short adits and open cuts. Idle. (Aubury 05:115; 08:138; Eric 46:226)

COPPER—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Klondike						See Schofield
	Lucky Boy & Rosebud			18N	3E	H	A quartz vein carrying heavy iron sulphides and a little copper and gold. Two crosscut adits 80 feet long. Idle. (Eric 48:226; Lowell 14:385).
	Mammouth						See Superior
	McKee		9	18N	2E	H	Three claims near mouth of Diamond Creek; Little development. Idle. (Aubury 05:115; 08:138; Eric. 48:226)
	Monkey Creek		5	17N	4E	H	Pyrite and chalcopyrite in diorite; developed by short adits. Idle. (Aubury 05:116; 08:140; Eric 48:226)
	Nelsons prospect						On the north slope of Bear Mountain at the contact of serpentine and hornblende schist; serpentine is cut by stringers and veins of asbestos; no commercial ore developed. Idle. (Maxson 33:146-147)
24	Occidental group		2	17N	1E	H	Four claims adjoin Alta mine on the south; 450-foot crosscut adit; 110-foot shaft shows 2 feet of ore; another 110-foot shaft; good surface samples. Idle. (Aubury 05:114; 08:136; Eric 48:226; Laizure 25:288)
	Occidental No. 2						One claim near Copper Hill. Idle. (Aubury 05:114)
	Old Crow		2	18N	3E	H	A 2-foot quartz vein carrying pyrite and chalcopyrite; two crosscut adits did not cut the vein. Idle. (Eric 48:227; Lowell 14:385)

	Oriental						See Zoar
	Prudential		2	18N	2E	H	Two wide veins developed by an adit and shaft; iron sulphides with small amount of copper and zinc; chief values in gold. Idle. (Aubury 05:116; 08:139; Eric 48:227)
25	Salt Lake-California (Union)		35	18N	1E	H	Gossan 3600 feet long; several adits with drifts on the vein; 100-foot shaft on the vein; 400 tons of ore said to have averaged 18 percent copper and $1.50 in gold per ton. Idle. (Eric 48:227; Laizure 25:288-289; Lowell 16:382-383; Maxson 33:144)
	Sanger Peak		5?	17N	5E	H	Prospected by diamond drilling. (Eric 48:227; Laizure 25:288)
	Schofield (Klondike)		14	18N	3E	H	A quartz vein 4-5 feet wide in greenstone carries marcasite and chalcopyrite with some gold, a 300-foot adit 150 feet below outcrop. Idle. (Eric 48:227; Laizure 25:288-289; Lowell 14:383; Maxson 33:147)
	Superior (Atlantic-Pacific Mammoth)		26	18N	1E	H	Three adits; vein 2-4 feet wide; copper, gold, and silver averaged $20.00 per ton. Idle. (Aubury 05:114; 08:138; Eric 48:227; Laizure 25:289; Lowell 14:383)
	Tuesday Morning		15	18N	3E	H	Ore carries pyrite, chalcopyrite and gold. Idle. (Aubury 05:116; 08:139; Eric 48:227)
	Union						See Salt Lake-California
	Zaar (Zoar, Oriental)		35	18N	1E	H	Prominent gossan; several veins 4-6 feet wide; chalcopyrite with gold and silver; several shafts and 1500 feet of adits. Idle. (Eric 48:227; Laizure 25:288; Maxson 33:148-149)
	Zoar						See Zaar

GOLD

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Antone Kaus placer (Kaus)	Hugh L. Germain	1	16N	1E	H	On Craig's Creek; pieces of platinum worth as much as $25.00 have been found. Idle. (Crawford 96:129; Haley 23:85; Laizure 25:292; Logan 18:63; Lowell 14:388)
	Aurora hydraulic (Morgan)		36	16N	1E	H	High bench gravel 300 to 400 feet wide and 3 to 10 feet deep; partly cemented in places, heavy gold; equipped for small scale working. Idle. (Haley 23:85; Laizure 25:292; Lowell 14:387)
	Bald Hills placer		?	16N	1E	H	Pay gravel is over 6 feet deep; gold sluicing was done during winter months. Idle. (Crawford 94:100; Ireland 93:196)
	Bartlett		?	17N	5E	H	On the north side of Preston Peak near the east line of the county; four locations on a strong vein; high percentage of iron and copper sulfides; developed by shallow cuts. Idle. (Crawford 96:127)
	Baumgarten		?	16N	1E	H	Worked by ground sluicing. Idle. (Crawford 96:127)
26	Big Flat (Oro Grande, Oro Verde)	Lydia Wilke	1, 12 13, 14	15N	2E	H	A hydraulic mine on the east bank of Hurdy Gurdy Creek; talcose slate bedrock has many small veins of quartz; coarse gold. Idle. (Crawford 94:100; 96:127; Watts 92:196; herein)
	Black Diamond		?	14N	4E	H	Four claims; probably abandoned. Idle. (Laizure 25:290; Lowell 14:399)
	Burrows and Peak		?				On the Middle Fork of Smith River about 17 miles east of Gasquet. Idle. (Crawford 96:127)

Butler placer						French Hill channel 3 miles south of Gasquet. Idle. (Crawford 96:127)
Casey placer		?	16N	1E	H	On Myrtle Creek; ground sluicing. Idle. (Crawford 96:127)
Christensen		15?	16N	1E	H	A hydraulic mine at the mouth of South Fork of Smith River; 20-foot bank of gravel above a serpentine bedrock. Idle. (Crawford 96:127)
Clark Creek						Drift mining was done on Clark Creek near Peacocks. Idle. (Watts 92:197)
Cleary		33?	17N	2E	H	A placer on French Hill channel; 3 miles south of Gasquet; ground sluicing. Idle. (Crawford 96:127)
Coleman		3?	17N	3E	H	A placer mine on Monkey Creek; water for ground-sluicing from Temple Gulch. Idle. (Crawford 96:127-128)
Cooke		24?	17N	1E	H	A hydraulic mine on the Smith River, 3 miles below Gasquet. Idle. (Crawford 96:128; Logan 18:59)
Cook Creek (Coon Flat)		?	16N	2E	H	A placer on Coon Ridge, 8 miles south of Gasquet; gravel is 10-50 feet deep. Idle. (Crawford 96:128; Watts 93:197)
Craig's Creek (Hueniche)		11?	16N	2E	H	Bars along the creek were worked by ground-sluicing with cradle and rocker. Idle. (Crawford 94:100; 96:129; Logan 18:63; Watts 92:196)
Crescent (Crescent City, Oranna, Ora Anna)		23?	16N	1E	H	A quartz prospect in the Bald Hills district about 12 miles northeast of Crescent City; an adit 300 feet long on the vein; incline shaft sunk 70 feet; two veins average 6 feet in width. Idle. (Laizure 25:291; Lowell 14:390; Maxson 33:144; 93:129; McGregor 90:167-168; Watts 92:197)
Crescent City Beach Mine						See Yates Beach mine.

GOLD—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Darnell		32	17N	2E	H	In French Hill district; adjoins the Doctor Young mine; Idle. (Laizure 25:292; Lowell 14:387)
	Dave Savoy		32	17N	2E	H	A shallow deposit of gravel in the French Hill district worked by ground-sluicing. Idle. (Haley 23:85; Laizure 18:291; Lowell 14:387)
	Day Hawk (Shelly Creek Saddle mine)		22?	18N	3E	H	On Shelly Creek, 3 miles beyond Patrick Creek station; decomposed portions of a large porphyry dike are worked by ground sluicing; most gold recovered is coarse and rough; some flour gold and some small amounts of platinum are also recovered. Idle. (Laizure 25:291)
	Doctor Young		32	17N	2E	H	A hydraulic mine in the French Hill district. Idle. (Haley 23:85; Laizure 25:292; Lowell 14:387)
27	Early Ray group	Leon R. Hazenlocker	SE¼ SW¼ 9	17N	3E	H	Some terrace gravel above the highway near the mouth of Patrick Creek was worked on a small scale by Charles Hagen in 1941-1942; the gravel is about 12 feet deep above a serpentine bedrock; many smooth boulders; Hagen claimed gravel averaged 12 cents per yard; application for a patent was protested. Property is idle except for assessment work.
	Eastman						On Siskiyou Fork, 20 miles east of Gasquet; worked with rockers. Idle. (Crawford 96:128)
	Elkhorn		9, 16?	17N	3E	H	A former hydraulic mine at the mouth of Patrick Creek; now a hotel site. (Haley 23:85; Laizure 25:292; Logan 18:59; Lowell 14:387)

	Frank		32?	17N	2E	H	On French Hill channel, 3 miles south of Gasquet; worked by ground-sluicing. Idle. (Crawford 96:128)
28	French Hill	John H. Hopkins, Crescent City	32, 33	17N	2E	H	The French Hill channel, 800 to 1000 feet wide with slightly cemented gravel was worked by hydraulicking; some platinum recovered. Idle. (Crawford 96:126; Haley 23:85; Laizure 25:292; Logan 18:63; Lowell 14:387; Watts 92:196)
	Garrison		23?	16N	1E	H	A placer claim on Bald Hill, 12 miles southeast from Crescent City; worked by ground-sluicing. Idle. (Crawford 96:128)
	George Cook		35?	17N	1E	H	On the Middle Fork of Smith River about 3 miles below Adam's Station; gravel banks about 25 feet high on both sides of the river were worked by hydraulicking; some platinum with the gold. Idle. (Haley 23:85; Laizure 25:292; Lowell 14:388)
	George Washington		16	17N	3E	H	Two claims on Monkey Creek adjoining the Elkhorn mine. Idle. (Haley 23:85; Laizure 25:292; Logan 18:59; Lowell 14:387)
	Goose Creek						From $1.00 to $1.50 per day could probably be recovered with sluice and rocker. Idle. (Watts 92:197)
77	Hard Luck		13?	18N	2E	H	Six claims on Monkey Creek in the Monumental district, a quartz vein carrying gold and arsenical sulphides developed by two adits and several hundred feet of drifts; shipment of ore to Selby smelter said to assay $10.40 per ton in gold. Idle. (Laizure 25:290; Lowell 14:389; Maxson 33:143)
	Haynes Flat (Haines Flat)		27?	16N	2E	H	A hydraulic mine between Coon and Garden Creeks, 20 miles southeast of Crescent City; a well-defined channel 100 feet wide and 150 feet deep with 15 to 30 feet of blue gravel carrying coarse gold above a serpentine bedrock. Idle. (Crawford 96:128-129)

GOLD—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Hueniche (Craig's Creek)		11?	16N	2E	H	A bar in Craig's Creek 8 miles southwest of Gasquet; gravel about 8 feet deep. Idle. (Crawford 96:129)
	Jenkins Brothers		13?	17N	3E	H	New placers discovered on Siskiyou Fork of Smith River by Jenkins Brothers said to be extensive. Idle. (Watts 92:196)
	Jones Creek & vicinity						Parties who had prospected Jones Creek and the headwaters of the South Fork of Smith River reported that small wages could be made by washing gold-bearing gravels in these streams. (Watts 92:197)
	Kauss						See Antone Kaus
	Kelly						On the Smith River at the mouth of Patrick's Gulch; gravel was ground-sluiced. Idle. (Crawford 96:129)
	Lambert						A placer property at Big Flat, 25 miles southwest of Crescent City. Idle. (Crawford 96:129)
	Larsen						An old bar on Myrtle Creek; gravel was ground-sluiced. Idle. (Crawford 96:129)
	Last Chance						A quartz vein said to assay $7.00 per ton about a mile south of Gasquet. Idle. (Watts 92:197)
	Marshall		?	17N	3E	H	A gravel deposit on the Siskiyou Fork of Smith River. (Laizure 25:292)
	Mayne						At Big Flat, 25 miles southeast of Crescent City; gravel is worked by ground sluicing. Idle. (Crawford 96:129)

	Mill Creek						Drift mining and ground sluicing on Mill Creek about 6 miles east of Crescent City; gravel is 10 to 20 feet thick. Idle. (Crawford 94:196)
	Miller						A hydraulic mine on Smith River, 6 miles east of Crescent City. Idle. (Crawford 94:100)
	Monkey Creek		10?	17N	3E	H	A placer property on Monkey Creek; benches were ground sluiced. Idle. (Haley 23:85; Laizure 25:292; Logan 18:59; Lowell 14:388)
29	Monumental Consolidated Quartz Mine	W. V. Stanfield, Wallace, Idaho	1	18N	3E	H	A quartz vein carrying gold and some copper developed by a vertical shaft 240 feet deep and a number of prospect tunnels 30 to 40 feet long. Herein. Idle. (Laizure 25:290; Lowell 14:389; Maxson 33:143-144)
	Morgan (Aurora)		?	16N	1E	H	A deposit of high bench gravel 300-400 feet wide and 3 to 10 feet deep; partly cemented in places; gold is heavy; water limited. Idle. (Laizure 25:292)
	Morrell		?	16N	1E	H	A deposit of bench gravel adjacent to the French Hill and Morgan mines; worked in a small way by the owner. (Laizure 25:292-293)
	Musick						Adjoins the Miller mine on the Smith River, 6 miles east of Crescent City; gravel is 1-4 ft. deep. Some platinum was recovered with the gold. Idle. (Crawford 94:100)
	Myrtle Creek placer (Waganer)		3, 4, 10	16N	1E	H	Eighteen claims along Myrtle Creek; pay gravel covered by heavy overburden and operation was unprofitable; some platinum was recovered with the gold. Idle. (Crawford 96:130; Haley 23:85; Laizure 25:293; Logan 18:59; Lowell 14:388; Watts 92:195-196)
	Myrtle Creek quartz		4	16N	1E	H	A quartz mine was operated on Myrtle Creek for 3 years prior to 1892 until the mill was burned. Idle. (Watts 92:197)

GOLD—Continued

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION Sec.	T.	R.	B&M	REMARKS
	Nels Christensen						Bench gravel near the forks of Smith River was hydraulicked in winter months; some platinum occurs with the gold. Idle. (Haley 23:85; Laizure 25:293; Logan 18:60; Lowell 14:388)
30	Oak Flat and East Fork groups (Patrick Creek)	Don Raymond et al Patrick Creek, via Gasquet	33	18N	3E	H	Bench and Creek gravel along Patrick Creek worked by ground sluicing; herein. (Haley 23:85; Laizure 25:293; Lowell 14:388)
	Ora Anna						See Crescent
	Oro Del Norte						Beach land along the ocean 2 miles south of Crescent City; a Heintz electric floatation plant for recovering gold and platinum from beach sands was a failure. Abandoned. (Laizure 25:285; Logan 18:41; Lowell 14:375-379; Maxson 25:143)
	Oro Grande Mines						See Big Flat
	Oro Pino prospect						A quartz vein on the east side of Bald Hill; incline shaft 75 feet deep; fine and flaky gold is found in pockets in the vein. Idle. (Maxson 33:144)
	Oro Verde						See Big Flat
	Patrick Creek						See Oak Flat and East Fork group
	Rice's						A 20-acre bar on Mill Creek was worked by sluicing; coarse gold lies exclusively on bedrock. Idle. (Crawford 94:100; 96:129)

Rice and Murray						A hydraulic mine on the South Fork of Smith River, 11 miles southeast of Crescent City; gravel is 25 feet deep. Idle. (Crawford 96:129)
Shelly Creek Saddle						See Day Hawk
Sweet Marie		?	14N	1E	H	A quartz vein 4 feet wide carrying free gold and sulfides; adits 30, 50 and 70 feet long. Idle (Laizure 25:291)
Torrejon						A placer claim in Redwood Gulch on the French Hill channel worked by ground-sluicing. Idle. (Crawford 96:130)
Waganer						See Myrtle Creek
Washington						A placer mine on Monkey Creek 15 miles east of Gasquet. Idle. (Crawford 96:130)
Walter Cook						A hydraulic mine on French Hill worked during winter months only. (Haley 23:85; Lowell 14:388-389)
Whitney						A placer claim on the French Hill Channel, 3 miles south of Gasquet; water for ground sluicing was taken from small gulches. Idle. (Crawford 96:130)
Winsch						A hydraulic mine on the French Hill channel 3 miles south of Gasquet. Idle. (Crawford 96:130)
Yates Beach mine						On the ocean beach 3 miles south of Crescent City; beach sand was worked for gold and platinum with a series of screens and tables. Idle. (Crawford 94:100-101; 96:128; herein)

MANGANESE

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
	Siskiyou Fork Trail		11	17N	3E	H	Oxide films on schist; uncommercial. Idle. (Trask 43:110; 50:50-51)
	Stone	Robert Stone	35?	18N	1E	H	Manganiferous chert; low grade. Idle. (Trask 43:110; 50:50-51)

MISCELLANEOUS STONE

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
34	Basalt Rock Company (Preston Island)		30	16N	1W	H	The rock used to build the jetties in Crescent City harbor was quarried here in 1947. (O'Brien 48:339; herein)
35	Crescent City Rock & Sand Co.	Presly Tryon, Fort Dick	11	17N	1W	H	A crushing and screening plant was operated intermittently. Material used to build and repair roads. (O'Brien 48:339-340; herein)
36	Point St. George (Macco-Morrison-Knudson Co.)	McNamara estate, Crescent City	13	16N	2W	H	The rock used to build the jetties in Crescent City harbor was quarried here in 1949.
	Sandstone deposit		22	16N	1E	H	Sandstone suitable for building stone has been worked to a limited extent. Idle. (McGregor 90:167)

QUICKSILVER

MAP NUMBER	CLAIM, MINE OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			Sec.	T.	R.	B&M	
31	Big Boy cinnabar group	O. H. Hayberg, H. W. Lipple, George Davis	36	19N	2E	H	A low grade cinnabar deposit in altered diorite; attempts to concentrate in sluices failed. Idle. (Maxson 33:157-159; Ransome 39:375; herein)
	Diamond Creek Cinnabar Co.		NW¼ 11	18N	2E	H	See Sunny Brook
32	Sunny Brook Prospect (Diamond Creek)		NW¼ 11	18N	2E	H	A vein showing native quicksilver and cinnabar in serpentine. Idle. (Aubury 03:195; Bradley 18:41; Laizure 25:293-294; Lowell 14:390; Maxson 33:156-157; Ransome 39:375-376; Watts 92:198; herein)
33	Webb (Patrick Creek, High Dome, Schults Bros., Wilmot)	David Webb, Kerby, Oregon	SE¼ 20	18N	3E	H	(O'Brien 39:78, 325; 48:338; herein)

MINERAL COMMODITIES IN CALIFORNIA DURING 1950

By Henry H. Symons * and Fenelon F. Davis **

OUTLINE OF REPORT

MINERAL PRODUCTION IN CALIFORNIA FOR 1950

The total value of mineral output in California during 1950 exceeded the billion-dollar mark for the third consecutive year, although it was less than the two preceding years. The all-time high was in 1948. The total value of California mineral output for 1950 was $1,056,047,000 † compared with $1,074,416,000 in 1949, and $1,146,411,000 in 1948, as compiled by the United States Bureau of Mines.

All previous annual production figures for quantity and value were surpassed in 1950 by boron minerals, cement, gypsum, iodine, lead, sand and gravel, sodium carbonate and sulfate, and talc (including pyrophyllite and soapstone). Other mineral substances showing an increase in value over 1949 were calcium chloride, clay, copper, iron ore, lime, magnesium compounds, natural gas, peat, pumice and pumicite, potash, silver, stone, sulfur, and zinc.

The increases noted above were not enough to offset the decreases in value of petroleum and natural gas liquids (natural gasoline and liquefied petroleum gases).

Antimony. During 1950 a small amount of antimony ore was mined at the Mountain group, 4½ miles southwest of Corona, Riverside County. Ore was stockpiled at the mine and no shipments were made.

Asbestos. The asbestos mined and shipped during 1950 came from two properties in Shasta County, and one property in Inyo County. All of the asbestos shipped during 1950 was of the tremolite variety, and was used either for acid filters, or as a filler material.

Barite. Barite produced in California during 1950 came from properties in Kern and Plumas Counties. The material from Kern County was used in oil-well drilling, and that from Plumas County in the manufacture of barium chemicals.

Boron Minerals. An all-time high was reached in both quantity and value of borates shipped during 1950. Shipments from California deposits totaled 647,735 short tons, (containing 190,932 tons of B_2O_3), valued at $15,890,000. This was an increase of 38 percent over the 1949 figures of 467,592 short tons, (139,200 tons of B_2O_3), valued at $11,511,893.

Shipments of borate minerals were made from two properties in Inyo County, two properties in San Bernardino County, and one property in Kern County during the year.

---

* Assistant mining engineer, California Division of Mines.
** Associate mining geologist, California Division of Mines. Manuscript submitted for publication June 1952.
† Figure revised since July 1952.

*Mineral production in California during 1950.**

Commodity	Short tons (unless otherwise stated)	Value
Boron minerals	647,735	$15,890,000
Cement (including clay used for cement) (barrels of 376 pounds net)	26,685,004	65,258,675
Clay (except for cement)	1,454,846	2,904,750
Copper ..... Cu content in pounds	1,292,000	268,736
Gold ..... troy ounces, Au content	412,118	14,424,130
Gypsum	962,373	2,462,604
Lead ..... Pb content in pounds	31,662,000	4,274,370
Lime	171,440	2,722,835
Manganese ore ..... long tons	677	7,529
Mercury ..... flasks, 76 pounds Hg	3,850	313,000
Natural gas ..... thousand cubic feet	[1]558,398,000	[1]66,449,000
Natural-gas liquids:		
Natural gasoline and cycle products barrels of 42 gallons	[1]21,246,677	[1]65,527,000
Liquefied petroleum gases ..... barrels of 42 gallons	[1]7,081,848	[1]14,497,000
Peat	6,399	37,192
Petroleum (crude) ..... barrels of 42 gallons	[1]327,607,000	[1]707,630,000
Pumice and pumicite	157,497	970,826
Salt	868,496	3,816,655
Sand and gravel	41,894,039	35,547,558
Silver ..... troy ounces, Ag content	1,071,917	970,139
Stone:		
Granite (dimension stone in cu. ft.)	77,650	259,447
Limestone[2] (includes dolomite)	1,065,439	2,899,767
Miscellaneous	10,681,421	10,839,218
Talc, soapstone, and pyrophyllite	109,747	2,069,211
Zinc ..... Zn content in pounds	15,102,000	2,144,484
Other minerals[3]	-----	33,862,874
Total	-----	[1]$1,056,047,000

* Revised figures.
[1] Preliminary figures.
[2] Except limestone for cement and lime.
[3] Abrasive stone, antimony, asbestos, barite, bromine, calcium chloride, carbon dioxide, chromite, coal (lignite), diatomite, feldspar, gems, iodine, iron ore, lithium minerals, magnesite, magnesium compounds from sea water, molybdenum concentrates, perlite, platinum group metals, potassium salts, pyrite, quartz, ground sand and sandstone, slate, sodium carbonate, sodium sulfate, sulfur, titanium concentrates, and tungsten concentrates.

Bromine. The bromine produced in California during 1950 came from single properties in Alameda and San Bernardino Counties. The material in Alameda County was recovered from sea-water bitterns purchased from the salt works on San Francisco Bay. The San Bernardino County production was extracted from the brines at Searles Lake. Most of the bromine was used in the manufacture of ethylene dibromide for antiknock gasoline, while minor amounts were used in the preparation of photographic emulsions and chemical reagents.

Calcium Chloride. Calcium chloride produced in California during 1950 totaled 21,875 short tons, (13,503 tons of 75 percent equivalent $CaCl_2$), valued at $266,542. This production compared with 11,166 tons of 75 percent equivalent $CaCl_2$ worth $204,024 in 1949. The material shipped in 1950 was the largest in both quantity and value of any year on record. Three properties in San Bernardino County accounted for the total production.

Carbon Dioxide (natural). Carbon dioxide was produced in 1950 from wells near Niland, Imperial County, and Hopland, Mendocino County. Most of the carbon dioxide was used in the manufacture of dry ice. The carbon dioxide gas produced from Imperial County totaled 128,990 thousand cubic feet.

Value of mineral production in California in 1950 by counties.

County	Value	County	Value
Alameda	$11,422,607	Placer	$470,443
Alpine, Colusa and Tehama	110,980	Plumas	51,205
Amador	1,026,560	Riverside	13,678,912
Butte	1,236,778	Sacramento	17,390,582
Calaveras	5,200,812	San Benito	3,061,211
Colusa, see Alpine		San Bernardino	48,351,102
Contra Costa	1,220,745	San Diego	3,689,238
Del Norte	168,164	San Francisco	0
El Dorado	1,830,702	San Joaquin	2,562,856
Fresno	116,217,195	San Luis Obispo	10,411,101
Glenn	189,554	San Mateo	6,744,555
Humboldt	591,273	Santa Barbara	68,494,959
Imperial	2,247,951	Santa Clara	13,814,298
Inyo	11,740,190	Santa Cruz	4,833,915
Kern	212,880,467	Shasta	1,599,619
Kings	20,135,973	Sierra	619,719
Lake	71,052	Siskiyou	618,148
Lassen	31,284	Solano	9,589,775
Los Angeles	258,337,408	Sonoma	942,495
Madera	1,624,305	Stanislaus	597,253
Marin	450,808	Sutter	102,834
Mariposa	392,500	Tehama, see Alpine	
Mendocino	399,497	Trinity	274,480
Merced	694,439	Tulare	1,145,202
Modoc	202,013	Tuolumne	839,571
Mono	508,477	Ventura	107,741,360
Monterey	4,834,818	Yolo	381,634
Napa	407,682	Yuba	2,519,181
Nevada	3,737,181	Unable to segregate by counties	70,199
Orange	77,539,738		
		Total value	$1,056,047,000

Cement. New all-time highs in the quantity and value of cement shipments were attained in 1950. Shipments from 11 California mills totaled 26,685,004 barrels, valued at $65,285,675. This was an increase of 14 percent over the value of shipments in 1949. In the latter year shipments totaled 23,201,982 barrels valued at $57,464,213. Production totaled 26,277,209 barrels in 1950, as compared with 23,218,356 in 1949.

Three mills in San Bernardino County, and one mill in each of the following counties, Calaveras, Kern, Los Angeles, Riverside, San Benito, San Mateo, Santa Clara, and Santa Cruz, contributed to the production. The five northern California mills shipped 11,797,448 barrels valued at $28,167,050 in 1950, while the six southern California mills shipped 14,887,556 barrels of cement valued at $37,091,625.

The estimated capacity of all cement mills in the state was 30,870,000 barrels in 1950, compared with 29,870,000 in 1949.

Chromite. The chromite mined and shipped in California during 1950 came from a single property near Magalia in Butte County. The 1950 shipments of chromite were less than the 433 short tons worth $11,662 reported in 1949. The latter production came from properties in Butte, Del Norte, and Tehama Counties.

Crude Clay. The crude clay produced in California during 1950 came from 102 pits in 27 counties, and totaled 2,285,147 short tons worth $3,527,477. Of this quantity, 830,301 tons worth $622,727 went into the manufacture of cement. The remaining 1,454,846 tons valued at $2,904,-750 were used by the ceramic industry, as oil-well drilling mud, as fillers,

and in other industrial uses. During 1949 the production of 1,391,088 short tons of clay (not including that used in cement) worth $2,744,069 was reported from California properties.

The 1950 output consisted of 405,179 short tons of fire clay (including stoneware clay) worth $1,000,838; miscellaneous clay output totaled 1,847,382 short tons, worth $1,922,725; and kaolin, china clay, bentonite, and fuller's earth production totaled 32,586 short tons worth $603,914.

California clay production in 1950 by counties (not including clay used in the manufacture of cement).

County	Quantity in short tons	Value
Alameda	17,500	$23,442
Amador	110,595	292,125
Kern	93,026	524,084
Los Angeles	481,747	373,359
Orange	23,611	115,245
Riverside	209,556	562,501
Sacramento	31,606	34,817
San Bernardino	24,763	291,492
Santa Clara	94,306	71,806
Calaveras, Contra Costa, Fresno, Humboldt, Imperial, Inyo, Marin, Placer, San Benito, San Diego, San Joaquin, Santa Barbara, Stanislaus, Sutter, Tulare, Ventura*	368,136	615,879
Totals	1,454,846	$2,904,750

* Combined to conceal the output of individual producers.

Coal (Lignite). In 1946 work was started on a plant to extract montan wax from the local lignite at Ione, Amador County. This plant began operating in 1947 and the company has been mining a small tonnage of coal annually. The montan wax from this plant is used in such products as shoe polish, carbon paper, and as a substitute for carnauba wax. A van dyke brown pigment is also made from coal at this plant and is used in paints and polishes. The plant residue is used as a soil conditioner.

California copper production in 1950 by counties.

County	Pounds	Value
Calaveras	196,700	$40,914
Imperial	100	21
Inyo	437,200	90,937
Plumas	8,200	1,706
Riverside	1,300	270
San Bernardino	219,300	45,614
Shasta	428,200	89,066
Tuolumne	1,000	208
Totals	1,292,000	$268,736

Copper. The recoverable copper produced in California during 1950 totaled 1,292,000 pounds worth $268,736, compared with 1,298,000 pounds worth $255,706 in 1949. The 1950 copper output by counties is shown in the accompanying table.

Diatomite. The diatomite mined in California during 1950 came from properties of two companies. One company operated a deposit in Los Angeles County; the other company operated a deposit in Santa Barbara County.

Feldspar. During 1950 a small amount of feldspar was mined and shipped from a single property in San Bernardino County. The 1949 shipments came from one property in Inyo, one in Madera, and one in San Bernardino Counties.

Gold. The California gold production during 1950 totaled 412,118 fine ounces worth $14,424,130, compared with 417,231 fine ounces worth $14,603,085 in 1949. The gold produced in 1950 came from 34 counties, of which 163,815 fine ounces came from 243 lode properties and 248,303 fine ounces from 186 placer properties.

Nevada County led in the value of the gold yield in 1950 with a total of $3,705,870; in second place was Sacramento County with $3,435,320;

Mine production of gold in California in 1950 by counties.

County	Mines producing[1]		Gold			
			Lode	Placer	Total	
	Lode	Placer	Fine ounces	Fine ounces	Fine ounces	Value
Amador	9	4	19,516	498	20,014	$700,490
Butte	1	5	20	19,434	19,454	680,890
Calaveras	10	8	2,086	625	2,711	94,885
Del Norte	1	----------	22	----------	22	770
El Dorado	12	9	1,293	2,567	3,860	135,100
Fresno	1	3	2	156	158	5,530
Humboldt	1	1	8	88	96	3,360
Imperial	5	----------	1,759	----------	1,759	61,565
Inyo	32	----------	6,483	----------	6,483	226,905
Kern	29	2	5,894	303	6,197	216,895
Lassen	1	----------	70	----------	2	70
Los Angeles	4	2	79	215	294	10,290
Madera	1	11	92	1,076	1,168	40,880
Mariposa	19	8	963	5,782	6,745	236,075
Merced	----------	3	----------	7,261	7,261	254,135
Modoc	3	----------	24	----------	24	840
Mono	5	----------	606	----------	606	21,210
Monterey	1	----------	21	----------	21	735
Nevada	7	21	[4]103,232	2,650	105,882	3,705,870
Placer	3	13	313	714	1,027	35,945
Plumas	4	3	35	311	346	12,110
Riverside	8	----------	59	----------	59	2,065
Sacramento	1	11	49	98,103	98,152	3,435,320
San Bernardino	30	2	2,251	509	2,760	96,600
San Diego	4	----------	55	----------	55	1,925
San Joaquin and Stanislaus[2]	----------	5	----------	14,312	14,312	500,920
Shasta	9	3	476	7,299	7,775	272,125
Sierra	12	17	17,262	355	17,617	616,595
Siskiyou	10	26	315	13,493	13,808	483,280
Trinity	3	15	50	7,481	7,531	263,585
Tulare	2	[3]	5	8	13	455
Tuolumne	14	4	843	37	880	30,800
Yuba	1	10	[4]	65,026	65,026	2,275,910
Total: 1950	243	186	163,815	248,303	412,118	$14,424,130

[1] Excludes itinerant prospectors, snipers, high-graders, and others who gave no evidence of legal right to property.
[2] Combined to avoid disclosure of individual output.
[3] **From property not classed as a mine.**
[4] Yuba County lode gold and lode silver included with Nevada County.

Yuba County was third with $2,275,910; followed in turn by Amador, Butte, and Sierra Counties. The gold from Amador, Nevada, and Sierra Counties was mostly from the lode or deep mines; while that from Butte, Sacramento, and Yuba Counties came from dredging operations.

The following quotation from Maurer [1] gives an outline of California gold mining activities for 1950:

> Preliminary data indicate that in 1950 placer mines, although adversely affected by floods in December, contributed about 60 percent of the State's gold while lode mines, confronted with a man-power shortage late in the year, supplied 40 percent, maintaining the ratio of 1949. Bucket-line dredges produced a preponderant percentage of the placer gold; leading producers were dredges of Yuba Consolidated Gold Fields operated in Yuba, Butte and Siskiyou Counties and the Natomas Co. and Capital Dredging Co. dredges in the Folsom district, Sacramento County. Activity of dragline operations, in conjunction with both floating and nonfloating washing plants, waned in 1950; the principal dragline dredges were operated by General Dredging Co., Folsom district, Sacramento County and Thurman Gold Dredging Co., Hunter Valley district, Mariposa County. Suction dredging was practiced in favorable localities, but a relatively small amount of gold was recovered by that method. Hydraulic and drift mining continued to be minor and definitely seasonal. Dredges worked by the Gold Hill Dredging Co., Oroville district, Butte County and the French Gulch Dredging Co., Deadwood district, Siskiyou County, suspended operations in 1950.
>
> Mines in 1950, which produced the major percent of California's lode gold included: Empire Star Mines Co. Ltd. group in the Grass Valley-Nevada City district, Nevada County and Browns Valley district, Yuba County; Idaho Maryland Mines Corp. Idaho and Brunswick units, Grass Valley-Nevada City district, Nevada County; Central Eureka Mining Co. Old Eureka mine, Mother Lode district, Amador County; and the Original Sixteen to One mine, Alleghany district, Sierra County. Among companies that also contributed to the State total lode gold were: Burton Bros., Mojave district, Kern County and the Butte Lode Mining Co., Randsburg district, San Bernardino County. The Sarita Milling Co. Masonic district, Mono County; the Holmestake Mining Co. Cargo Muchacho district, Imperial County; the Mill Creek Mining Co. (Quartz Hill mine) Scott River district, Siskiyou County; and Best Mines Co. Brush Creek mine, Downieville district, Sierra County, resumed operations in 1950.

Gypsum. The 1950 output of gypsum was the largest annual production in both quantity and value so far reported in the state. The crude gypsum produced from California deposits during 1950 totaled 962,373 short tons valued at $2,462,604. Production came from four properties in Kern County, three properties in Fresno County, two properties in Riverside County, and one property each in Imperial, Kings, and Ventura Counties. In addition to the above, but not included in the state total, was a considerable quantity of synthetic gypsum produced as a by-product in the reduction of magnesia from sea water at a plant in Alameda County.

Gypsum sold to California agriculturists as a soil conditioner in 1950 totaled 327,970 short tons, compared with 338,340 short tons in 1949.

Iodine. California is the only state in which iodine is recovered. Two companies produced iodine in California during 1950 from oil-well waters in Los Angeles County.

Iron Ore. The production of iron ore in California during 1950 totaled 831,445 long tons, compared with 536,525 long tons in 1949. Shipments of iron ore from the state in 1950 were 849,489 long tons compared with 584,109 long tons in 1949.

---

[1] Maurer, R. B., Metal mining in California, 1950: U. S. Bur. Mines Mineral Market Report No. 1935.

Principal production was from the Eagle Mountain mine in Riverside County which shipped to the Kaiser Company, Fontana steel mill. Iron ore was also shipped from the stock pile at the Vulcan mine in San Bernardino County although no mining was reported at this mine. A small production and shipment was reported from the Bessmer mine in San Bernardino County.

Lime. The lime manufactured in California during 1950 totaled 171,440 short tons worth $2,722,835, as compared with 153, 483 short tons worth $2,516,262 in 1949. The 1950 output of lime came from two plants each in El Dorado and San Bernardino Counties, and one plant each in Monterey and Tuolumne Counties.

During 1950 California agriculturists purchased 4,814 short tons of by-product lime and 1,782 short tons of hydrated lime for use as soil conditioners.

Limestone. See *Stone.*

Lithium Minerals. The brines of Searles Lake, San Bernardino County, California are the chief source of the nation's lithium. Lithium-sodium phosphate was produced in 1950.

Magnesite. The magnesite mined and shipped in California during 1949 and 1950 consisted of a small tonnage of hand-sorted ore, and a lesser amount of flotation concentrates produced from a property at Red Mountain, in Santa Clara County.

Magnesium Compounds (from sea water and bitterns). Magnesia (magnesium oxide) was produced during 1950 in California from sea water, bitterns, and dolomite. The three producing plants were located in Alameda, Monterey, and San Mateo Counties. The plant in San Mateo County also produced magnesium carbonate and hydroxide. The magnesium salts from this plant were all U.S.P. or technical grade, and were used in pharmaceuticals. The material from Alameda and Monterey Counties was used in refractories, oxychloride cements, rayon, insulation, epsom salts, and for other purposes. Magnesium chloride was recovered in a plant at Chula Vista, San Diego County.

Insulation manufacturers in Alameda and San Mateo Counties purchased magnesium oxide from the primary producers and converted it into magnesium carbonate for pipe coverings.

Manganese Ore. During 1950 shipments of manganese ores in California totaled 677 long tons, which contained 156 tons of manganese valued at $7,529. Production came from single properties in Plumas, Riverside, Siskiyou, and Trinity Counties. The 1949 manganese output was 595 long tons (revised figure) containing 179 tons of manganese valued at $8,089. It came from properties in Plumas and San Bernardino Counties. The material coming from Trinity County in 1950 was metallurgical grade ore, while that from the other counties was ferruginous manganese ore.

Mineral Water. Water from many springs and artesian wells, bottled and in part artificially carbonated, is classed as mineral water. Health and pleasure resorts are located at many hot springs in California. The water at some of the hot springs is not suitable for drinking, but is utilized for bathing. Counties from which mineral waters are bottled and sold are: Butte, Calaveras, Contra Costa, Lake, Los Angeles, Marin,

6—64960

Napa, Orange, Riverside, San Benito, San Bernardino, San Diego, San Francisco, San Luis Obispo, Santa Barbara, Shasta, Siskiyou, Sonoma, and Tehama. No canvass of mineral water producers is made by the U. S. Bureau of Mines.

Mineral Pigments. Mineral pigments manufactured in California during 1950 came from plants in Alameda and Amador Counties. The former produced iron-colored pigments, and the latter produced a van dyke brown made from coal.

Molybdenum. Molybdenum concentrates were produced in California as a by-product of tungsten recovery. The 1949 and 1950 output came from the Pine Creek mine of the U. S. Vanadium Corporation near Bishop, Inyo County.

Natural Gas. The value of natural gas production in California during 1950 was the highest on record, although the quantity of production was below the figure reported in 1948. Production was reported from wells in 21 counties. The output of natural gas utilized was 558,398,000 thousand cubic feet worth $66,449,000 at the well in 1950 as compared

Natural gas production in California in 1950 by counties.

County	Thousand cubic feet	Value
Fresno	62,427,000	$7,728,000
Glenn	1,034,000	130,000
Humboldt	1,269,000	149,000
Kern	73,683,000	8,715,000
Kings	35,627,000	4,349,000
Los Angeles	104,796,000	10,742,000
Madera	2,525,000	343,000
Orange	25,452,000	2,709,000
Sacramento	90,756,000	12,667,000
San Joaquin	6,213,000	868,000
Santa Barbara	18,031,000	1,563,000
Solano	67,270,000	9,388,000
Tulare	3,427.000	453,000
Ventura	60,543,000	5,967,000
Butte, Contra Costa, Monterey, San Luis Obispo, Stanislaus, Sutter, and Yolo*	5,345,000	678,000
Totals	558,398,000	$66,449,000

* Combined to conceal output of individual producers.

Natural gas liquids produced in California in 1950, by counties.

County	Number of plants	Natural gasoline		Liquefied petroleum gases	
		Barrels of 42 gal.	Value	Barrels of 42 gal.	Value
Fresno	6	1,663,912	$5,453,000	1,216,051	$2,440,000
Kern	19	6,871,009	21,612,000	2,843,066	6,509,000
Kings and San Luis Obispo	3	1,165,312	3,751,000	827,530	1,760,000
Los Angeles	28	6,065,088	18,472,000	734,609	1,316,000
Orange	8	2,631,398	7,863,000	216,193	360,000
Santa Barbara	7	630,481	1,864,000	240,098	383,000
Ventura	8	2,219,477	6,512,000	1,003,937	1,729,000
Totals	79	21,246,677	$65,527,000	7,081,484	$14,497,000

with 539,550,000 thousand cubic feet worth $65,825,000 at the well in 1949.

Natural Gas Liquids. Natural gas liquids were recovered in 79 plants located near the oilfields in California during 1950. Liquefied petroleum gases were recovered at 41 of these plants.

Natural gasoline and cycle products produced in California during 1950 totaled 21,246,677 barrels worth $65,527,000, as compared with 20,527,000 barrels worth $65,827,000 in 1949.

Liquefied petroleum gases produced in California during 1950 totaled 7,081,484 barrels worth $14,497,000, as compared with 6,555,000 barrels worth $19,080,000 in 1949.

Peat. During 1950 peat gathered from peat bogs in Modoc, Orange, and San Diego Counties totaled 6,399 tons, worth $37,192. This compares with 5,670 tons worth $35,193 produced in California during 1949.

Perlite. Crude perlite was produced during 1950 from properties in Inyo, Napa, and San Bernardino Counties. Expanding plants were operated in Contra Costa, Los Angeles, Marin, Napa, and San Bernardino Counties. The reported output of expanded perlite for the year was 12,179 short tons valued at $648,879.

Petroleum. California ranks second among the states in the output of crude oil. Petroleum leads all mineral substances in value of production in California, and accounted for approximately 67 percent of the state's total in 1950. During 1950 the petroleum output totaled 327,607,000 barrels worth $707,630,000, compared with 332,839,000 barrels worth $752,220,000 in 1949.

Petroleum production in California by counties for 1949 and 1950.

Counties	1949		1950	
	Barrels of 42 gallons	Value	Barrels of 42 gallons	Value
Fresno	43,843,000	$107,309,000	41,265,000	$99,778,000
Kern	92,045,000	204,849,000	84,017,000	159,126,000
Kings	5,156,000	13,507,000	4,356,000	11,235,000
Los Angeles	93,421,000	216,151,000	96,870,000	210,898,000
Orange	37,129,000	77,742,000	33,918,000	65,048,000
San Luis Obispo	2,718,000	7,302,000	3,503,000	9,003,000
Santa Barbara	24,010,000	43,875,000	29,592,000	59,784,000
Ventura	34,032,000	80,860,000	33,889,000	92,550,000
Monterey, San Benito, San Bernardino, Santa Clara, and Sonoma*	485,000	625,000		
Monterey, San Benito, San Bernardino, Santa Clara, Sonoma, and Tulare*			197,000	208,000
Totals	332,839,000	$752,220,000	327,607,000	$707,630,000

* Combined to conceal output of individual producers.

Sand and gravel production in California for 1950, by counties.

County	Short tons	Value
Alameda	5,213,928	$5,216,168
Butte	223,914	365,515
Contra Costa	304,608	160,275
Del Norte	160,519	167,316
Fresno	582,109	439,242
Humboldt	577,650	425,421
Imperial	776,921	492,682
Inyo	83,115	31,098
Kern	654,933	835,657
Lake	103,117	70,578
Los Angeles	15,127,334	9,835,428
Mendocino	254,413	263,487
Merced	496,486	330,025
Modoc	281,872	189,633
Mono	49,847	52,533
Monterey	718,748	1,384,646
Orange	1,484,362	1,244,818
Riverside	1,600,014	1,419,371
Sacramento	1,176,310	1,066,924
San Benito	300,648	161,001
San Bernardino	1,262,043	1,032,234
San Diego	2,016,162	2,850,624
San Joaquin	1,509,960	1,350,898
San Luis Obispo	431,859	290,363
Santa Clara	498,716	494,785
Shasta	310,800	171,245
Stanislaus	342,065	279,788
Sutter	61,407	18,034
Tehama	122,869	93,541
Tulare	369,773	403,753
Trinity	3,720	3,046
Ventura	703,974	646,769
Alpine, Amador, Calaveras, Colusa, El Dorado, Glenn, Lassen, Madera, Marin, Mariposa, Napa, Nevada, Placer, Plumas, San Mateo, Santa Barbara, Santa Cruz, Siskiyou, Sonoma, Tuolumne, Yolo, Yuba*	2,437,604	1,889,154
	40,241,800	$33,676,052
Not segregated by counties	1,652,239	1,871,506
Totals	41,894,039	$35,547,558

* Combined to conceal output of individual producers.

Platinum. Production of platinum group metals in 1950 was reported from dredging operations in Butte, Mariposa, Sacramento, Shasta, Siskiyou, Stanislaus, and Yuba Counties.

Potash. Potassium salts were produced in California during 1950 from the brines of Searles Lake, San Bernardino County, by the Ameri-Potash and Chemical Company.

Pumice and pumicite. Pumice and pumicite (volcanic ash) produced in California during 1950 totaled 157,409 short tons worth $969,196, compared with 149,878 short tons worth $799,602 in 1949. The material produced in Calaveras, Imperial, Inyo, Modoc, Mono, and Siskiyou, and part of that from Madera and San Bernardino Counties was pumice. The production from Kern County, and the remainder from Madera and San Bernardino Counties was pumicite or volcanic ash.

Pyrite. Pyrite produced in California during 1950 came from the Hornet Mine at Matheson, Shasta County. This mine has been the chief source of the state's pyrite for many years.

Quicksilver (mercury). Production of mercury in California during 1950 totaled 3,850 flasks of 76 pounds worth $313,000, compared with the 1949 output of 4,493 flasks worth $357,014. The 1950 output of mercury in California was the smallest since 1922, when 3,466 flasks of 75 pounds worth $191,851 was mined. The mercury mined during 1950 came from five properties in San Benito County, four in Santa Clara County, three in Sonoma County, and one mine each in Lake, Napa, and Yolo Counties.

Salt. The salt shipped in California during 1950 totaled 868,496 short tons worth $3,816,655, compared with 964,807 short tons worth $4,110,271 in 1949. The 1950 salt output came from four properties in Alameda County, two properties in San Bernardino County, and one property each in Monterey, Orange, and San Diego Counties.

Sand and Gravel. California lead all the states in the output of sand and gravel with approximately 12 percent of the nation's total. The 1950 output, largest of any year so far recorded in the state, totaled 41,894,039 short tons worth $35,547,558, compared with 36,279,816 short tons of sand and gravel worth $30,198,924 in 1949. Sand and gravel was reported from every county of the state with the exception of Kings, San Francisco, Sierra, and Solano.

Silver. The silver output in California for 1950 totaled 1,071,917 troy ounces worth $970,139, as compared with 783,880 troy ounces worth $709,451 in 1949. The lode mines accounted for 1,053,607 troy ounces of the 1950 silver yield and the placers for 18,310 troy ounces.

Silica (Quartz and Sand). The quartz mined in California during 1950 came from single properties in Mariposa and Kern Counties. Ganister (quartzite) was shipped from a property in San Bernardino County. Silica sand used in the manufacture of glass and in ceramics came from properties in Monterey and Riverside Counties. The annual details for quartz, and ground sand are concealed in the table of values under 'Other Minerals', and part of the figures for glass sand are combined with sand and gravel.

Slate. The slate mined in California during 1950 came from properties in El Dorado, Inyo, and Mariposa Counties. The production from El Dorado County and part of the production from Inyo County was used for roofing granules and slate flour. The Mariposa County production and the remainder from Inyo County was used as flagstone.

Soda and Saltcake. The 1950 production of sodium carbonate in California was the largest thus far reported. The sodium carbonate (soda ash and trona) produced in California during 1949 and 1950 came from properties of three companies operating on Owens Lake in Inyo County, and from properties of two companies on Searles Lake in San Bernardino County.

The saltcake production in California for 1949 and 1950 came from a property on Searles Lake, San Bernardino County.

Stone (Miscellaneous). The granite quarried in California during 1950 for monumental and building stone totaled 77,650 cubic feet (17,770 short tons) worth $259,447. It came from seven properties in San Diego County and single properties in Fresno, Lassen, Los Angeles, Mariposa, Mono, Placer, and San Bernardino Counties. The material

Mine production of silver in California during 1950 by counties.

County	Total	
	Fine ounces	Value
Amador	4,249	$3,845
Butte	1,380	1,249
Calaveras	12,503	11,316
Del Norte	11	10
El Dorado	788	713
Fresno	24	22
Humboldt	13	12
Imperial	429	388
Inyo	933,048	844,456
Kern	9,530	8,625
Lassen	1	1
Los Angeles	98	88
Madera	317	287
Mariposa	1,990	1,801
Merced	724	655
Modoc	11	10
Mono	2,990	2,706
Monterey	4	4
Nevada	31,281	28,311
Placer	483	437
Plumas	122	110
Riverside	865	783
Sacramento	4,490	4,084
San Bernardino	13,103	11,859
San Diego	12	11
San Joaquin and Stanislaus*	1,418	1,283
Shasta	41,817	37,846
Sierra	3,452	3,124
Siskiyou	1,802	1,631
Trinity	676	612
Tulare	1	1
Tuolumne	257	233
Yuba	4,028	3,646
Totals: 1950	1,071,917	$970,139

* Combined to conceal output of individual producers.

produced from Fresno, Lassen, Placer, and San Diego Counties was used chiefly as monumental stone.

The limstone and dolomite quarried in California during 1950 totaled 1,065,439 short tons worth $2,899,767. Production was made from four quarries in El Dorado and in San Bernardino Counties; three quarries in Tuolumne County; two in San Mateo, Santa Clara and Santa Cruz Counties; and one quarry in Kings, Monterey, Riverside, San Benito, San Diego, Siskiyou, and Ventura Counties.

Most of the limestone quarried in El Dorado, Riverside, San Bernardino, Santa Cruz, Tuolumne and Ventura Counties and part quarried from Santa Clara County was high grade limestone and was used as a flux in metallurgical processes; in the manufacturing processes for sugar, soda ash, paints, rubber, glass, chemicals; in agriculture; in chicken grit and poultry feed; as a filler; as granules for roofing and terrazzo; and other special uses. The material from Monterey and San Benito Counties, and part of the production from Tuolumne County was dolomite which was used in refractories, and as a chemical agent in the reduction of magnesia from sea water. The material produced from the other counties was used as crushed rock in concrete and as fill rock.

During 1950 a total of 10,681,421 short tons of crushed stone, rubble, fill rock and flagstone worth $10,839,218 was produced in California.

Miscellaneous stone production by counties in California for 1950.

County	Short tons	Value
Alameda	924,161	$862,783
Contra Costa	673,839	710,885
Fresno	223,279	219,762
Los Angeles	3,342,787	2,662,283
Merced	81,203	109,624
Orange	140,945	152,078
Riverside	47,709	44,905
San Luis Obispo	22,037	22,358
Santa Barbara	37,762	38,262
Santa Clara	471,475	309,656
Tuolumne	40,604	42,840
Solano	136,883	201,775
Sonoma	111,375	131,688
Amador, Butte, El Dorado, Humboldt, Imperial, Madera, Marin, Mariposa, Mendocino, Monterey, Napa, Placer, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Mateo, Santa Cruz, Shasta, Siskiyou, Trinity, Tulare, Ventura, Yolo, and Stanislaus*	4,358,827	5,234,251
Not segregated by counties	68,535	96,068
Totals	10,681,421	$10,839,218

* Combined to conceal output of individual producers.

Sulfur. A small production of native sulfur was mined and shipped in California during 1950 from a single property in Inyo County. The year's production was slightly larger than that of 1949. The Leviathan mine in Alpine County was idle during the year.

In addition to the native sulfur a much larger tonnage of by-product sulfur was recovered from sour petroleum refinery gases at a plant at Watson, Los Angeles County. Hydrogen sulfide was recovered at oil refineries at Richmond, Contra Costa County; and at Dominguez, El Segundo, and Watson in Los Angeles County.

Talc, Pyrophyllite, and Soapstone. The talc, pyrophyllite and soapstone mined and shipped in California during 1950 totaled 109,747 short tons worth $2,069,211. The material came from properties in El Dorado, Inyo, Los Angeles, Mono, San Bernardino, and San Diego Counties. In 1949, 83,359 short tons worth $1,434,046 was produced from the same counties. Most of the material coming from Inyo and San Bernardino Counties was high grade talc, although a small tonnage consisted of pyrophyllite; the production from Mono and San Diego

Talc, pyrophyllite, and soapstone produced in California during 1950.

County	Short tons	Value
Inyo	38,789	$585,260
San Bernardino	60,701	1,360,267
El Dorado, Los Angeles, Mono, and San Diego*	10,257	123,684
	109,747	$2,069,211

* Combined to conceal output of individual producers.

Counties was all pyrophyllite; and that from El Dorado and Los Angeles Counties was soapstone.

Titanium. A small tonnage of ilmenite concentrates was produced in California during 1949 and 1950, which came from a property in Sand Canyon, near Saugus, Los Angeles County.

Tungsten. High-grade tungsten concentrates mined in California and shipped during 1950 were more than double the 1949 shipments. In 1950 shipments of 2,025 short tons of tungsten concentrates valued at $3,392,000 were made from properties in Fresno, Inyo, Kern, Madera, Mono, Riverside, San Bernardino, and Tulare Counties.

Zinc. Mine production of recoverable zinc in California during 1950 totaled 15,102,000 pounds worth $2,144,484, as compared with 14,418,000 pounds, worth $1,787,832 in 1949.

Mine production of recoverable zinc in California in 1950 by counties.

County	Pounds	Value
Calaveras	651,000	$92,442
Inyo	11,561,700	1,641,761
San Bernardino	116,900	16,600
Shasta	2,772,400	393,681
Totals	15,102,000	$2,144,484

CONTRIBUTION OF THE COUNTIES TO THE MINERAL PRODUCTION OF CALIFORNIA DURING 1950

All 58 counties of California, with the exception of San Francisco County, reported mineral production during 1950. Forty-seven percent of the counties showed an increase in mineral production over 1949 and 24 percent of the counties reporting an all-time high in value of mineral production were Alameda, Imperial, Inyo, Monterey, Riverside, Sacramento, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz, Solano, and Ventura counties.

As usual, the six leading counties in value of mineral production were producers of petroleum and natural gas. Only two of these leaders however, Santa Barbara and Ventura Counties, showed an increase over the values reported in 1949. Although the 1950 value was slightly less than that reported in 1949, Los Angeles County headed the list of counties for the first time since 1943.

Other leading counties and the principal mineral commodities they produced are: San Bernardino, cement, potash, soda salts, sand-gravel, and talc; Sacramento, placer gold, natural gas, and sand-gravel; Santa Clara, cement; Riverside, cement and iron ore; Inyo, lead, zinc, and tungsten concentrates; Alameda, salt and sand-gravel; Solano, natural gas; Nevada, lode gold.

The most diversified mineral production was from San Bernardino County—holder of seventh place—where 29 mineral commodities were reported. The following counties also reported a diversified mineral production: Inyo, 17 commodities; Los Angeles and Kern, 15 commodities; Riverside, 13 commodities; Fresno and Monterey, 12 commodities; San Diego, 11 commodities; and Shasta, 10 commodities.

Mineral output by counties for 1950 in order of value.

County	Value	County	Value
1 Los Angeles	$258,337,408	29 Butte	$1,236,778
2 Kern	212,880,467	30 Contra Costa	1,220,745
3 Fresno	116,217,195	31 Tulare	1,145,202
4 Ventura	107,741,360	32 Amador	1,026,560
5 Orange	77,539,738	33 Sonoma	942,495
6 Santa Barbara	68,494,959	34 Tuolumne	839,571
7 San Bernardino	48,351,102	35 Merced	694,439
8 Kings	20,135,973	36 Sierra	619,719
9 Sacramento	17,390,582	37 Siskiyou	618,148
10 Santa Clara	13,814,298	38 Stanislaus	597,253
11 Riverside	13,678,912	39 Humboldt	591,273
12 Inyo	11,740,190	40 Mono	508,477
13 Alameda	11,422,607	41 Placer	470,443
14 San Luis Obispo	10,411,101	42 Marin	450,808
15 Solano	9,589,775	43 Napa	407,682
16 San Mateo	6,744,555	44 Mendocino	399,497
17 Calaveras	5,200,812	45 Mariposa	392,500
18 Monterey	4,834,818	46 Yolo	381,634
19 Santa Cruz	4,833,915	47 Trinity	274,480
20 Nevada	3,737,181	48 Modoc	202,013
21 San Diego	3,689,238	49 Glenn	189,554
22 San Benito	3,061,211	50 Del Norte	168,164
23 San Joaquin	2,562,856	51 Sutter	102,834
24 Yuba	2,519,181	52 Tehama (see Alpine)	
25 Imperial	2,247,951	53 Lake	71,052
26 El Dorado	1,830,702	54 Plumas	51,205
27 Madera	1,624,305	55 Lassen	31,284
28 Shasta	1,599,619	56 Colusa (see Alpine)	
		57 Alpine, Colusa, Tehama	110,980
		Not segregated by counties	70,199
		Total value	$1,056,047,000

Mineral Production in California in 1950 by Counties

Alameda County

Product	Quantity	Value
Clay, short tons	17,500	$23,442
Sand and Gravel, short tons	5,203,928	5,216,168
Stone, short tons	924,161	862,783
Unapportioned: Bromine, salt, magnesium compounds		5,320,214
Total value		$11,422,607

Alpine County

Mineral production in Alpine County in 1950 consisted of sand and gravel.

Amador County

Product	Quantity	Value
Clay, short tons	110,595	$292,125
Gold, troy ounces	20,014	700,490
Silver, troy ounces	4,249	3,845
Unapportioned: Coal (lignite), sand and gravel, and stone		30,100
Total value		$1,026,560

Butte County

Product	Quantity	Value
Gold, troy ounces	19,454	$680,890
Sand and gravel, short tons	223,914	365,515
Silver, troy ounces	1,380	1,249
Unapportioned: Chromite, natural gas, platinum, and stone		189,124
Total value		$1,236,778

Mineral Production in California in 1950 by Counties—Continued

Calaveras County

Product	Quantity	Value
Copper, pounds	196,700	$40,914
Gold, troy ounces	2,711	94,885
Lead, pounds	37,900	5,117
Silver, troy ounces	12,503	11,316
Zinc, pounds	651,000	92,442
Unapportioned: Cement, clay, pumice, and sand and gravel		4,956,138
Total value		$5,200,812

Colusa County

Mineral production in Colusa County for 1950 consisted of sand and gravel.

Contra Costa County

Sand and gravel, short tons	304,608	$160,275
Stone, short tons	673,839	710,885
Unapportioned: Clay and natural gas		349,585
Total value		$1,220,745

Del Norte County

Gold, troy ounces	22	$770
Lead, pounds	500	68
Silver, troy ounces	11	10
Sand and gravel, short tons	160,519	167,316
Total value		$168,164

El Dorado County

Gold, troy ounces	3,860	$135,100
Silver, troy ounces	788	713
Unapportioned: Lime, limestone, sand and gravel, stone, slate, and soapstone		1,694,889
Total value		$1,830,702

Fresno County

Gold, troy ounces	158	$5,530
Gypsum, short tons	14,689	20,079
Natural gas, thousand cubic feet	62,427,000	7,728,000
Natural-gas liquids:		
Natural gasoline, barrels	1,663,912	5,453,000
Liquefied petroleum gases, barrels	1,216,051	2,440,000
Petroleum, barrels	41,265,000	99,778,000
Sand and gravel, short tons	582,109	439,242
Silver, troy ounces	24	22
Stone, short tons	223,279	219,762
Unapportioned: Clay, granite, and tungsten concentrates		133,560
Total value		$116,217,195

Glenn County

Natural gas, thousand cubic feet	1,034,000	$130,000
Sand and gravel, short tons	165,113	59,554
Total value		$189,554

Humboldt County

Gold, troy ounces	96	$3,360
Natural gas, thousand cubic feet	1,269,000	149,000
Sand and gravel, short tons	577,650	425,421
Silver, troy ounces	13	12
Unapportioned: Clay and stone		13,480
Total value		$591,273

Mineral Production in California in 1950 by Counties—Continued

Imperial County

Product	Quantity	Value
Copper, pounds	100	$21
Gold, troy ounces	1,759	61,565
Sand and gravel, short tons	776,921	492,682
Silver, troy ounces	429	388
Unapportioned: Clay (bentonite), carbon dioxide, gypsum, pumice, and stone	-------------	1,693,295
Total value	-------------	$2,247,951

Inyo County

Product	Quantity	Value
Copper, pounds	437,200	$90,937
Gold, troy ounces	6,483	226,905
Lead, pounds	31,133,900	4,203,076
Sand and gravel, short tons	83,115	31,098
Silver, troy ounces	933,048	844,456
Talc and pyrophyllite, short tons	38,789	585,260
Zinc, pounds	11,561,700	1,641,761
Unapportioned: Asbestos, borates, clay (bentonite and fuller's earth), molybdenum concentrates, perlite, pumice, slate, sodium carbonates, sulfur, and tungsten concentrates	-------------	4,116,697
Total value	-------------	$11,740,190

Kern County

Product	Quantity	Value
Clay, short tons	93,026	$524,084
Gold, troy ounces	6,197	216,895
Gypsum, short tons	203,080	320,491
Natural gas, thousand cubic feet	73,683,000	8,715,000
Natural-gas liquids:		
Natural gasoline and condensates, barrels	6,871,009	21,612,000
Liquefied petroleum gases, barrels	2,843,066	6,509,000
Petroleum, barrels	84,017,000	159,126,000
Sand and gravel, short tons	654,933	835,657
Silver, troy ounces	9,530	8,625
Unapportioned: Barite, borates, cement, pumice, quartz, and tungsten concentrates	-------------	15,012,715
Total value	-------------	$212,880,467

Kings County

Product	Quantity	Value
Natural gas, thousand cubic feet	35,627,000	$4,349,000
Petroleum, barrels	4,356,000	11,235,000
Unapportioned: Gypsum, limestone, natural gas liquids (natural gasoline and liquefied petroleum gases)	-------------	4,551,973
Total value	-------------	$20,135,973

Lake County

Mineral production in Lake County in 1950 consisted of sand and gravel and mercury.

Lassen County

Product	Quantity	Value
Gold, troy ounces	2	$70
Silver, troy ounces	1	1
Unapportioned: Granite, and sand and gravel	-------------	31,213
Total value	-------------	$31,284

Mineral Production in California in 1950 by Counties—Continued

Los Angeles County

Product	Quantity	Value
Clay, short tons	481,747	$373,359
Gold, troy ounces	294	10,290
Natural gas, thousand cubic feet	104,796,000	10,742,000
Natural-gas liquids:		
Natural gasoline, barrels	6,065,088	18,472,000
Liquefied petroleum gases, barrels	734,609	1,316,000
Petroleum, barrels	96,870,000	210,898,000
Sand and gravel, short tons	15,127,334	9,835,428
Silver, troy ounces	98	88
Stone, short tons	3,342,787	2,662,283
Unapportioned: Cement, diatomite, granite, iodine, soapstone, and titanium concentrates		4,027,960
Total value		$258,337,408

Madera County

Gold, troy ounces	1,168	$40,880
Natural gas, thousand cubic feet	2,525,000	343,000
Silver, troy ounces	317	287
Unapportioned: Pumice, pumicite, sand and gravel, stone, and tungsten		1,240,138
Total value		$1,624,305

Marin County

Production of minerals in Marin County in 1950 consisted of clay, sand and gravel, and stone.

Mariposa County

Gold, troy ounces	6,745	$236,075
Lead, pounds	2,700	365
Silver, troy ounces	1,990	1,801
Unapportioned: Granite, platinum metals, quartz, sand and gravel, slate, and stone		154,259
Total value		$392,500

Mendocino County

Sand and gravel, short tons	254,413	$263,487
Unapportioned: Carbon dioxide and stone		136,010
Total value		$399,497

Merced County

Gold, troy ounces	7,261	$254,135
Sand and gravel, short tons	496,486	330,025
Silver, troy ounces	724	655
Stone, short tons	81,203	109,624
Total value		$694,439

Modoc County

Gold, troy ounces	24	$840
Sand and gravel, short tons	281,872	189,633
Silver, troy ounces	11	10
Unapportioned: Pumice and peat		11,530
Total value		$202,013

Mineral Production in California in 1950 by Counties—Continued

Mono County

Product	Quantity	Value
Gold, troy ounces	606	$21,210
Sand and gravel, short tons	49,847	52,533
Silver, troy ounces	2,990	2,706
Unapportioned: Granite, pumice, pyrophyllite, and tungsten concentrates		432,028
Total value		$508,477

Monterey County

Product	Quantity	Value
Gold, troy ounces	21	$735
Sand and gravel, short tons	718,748	1,384,646
Silver, troy ounces	4	4
Unapportioned: Dolomite, lime, magnesium salts, natural gas, petroleum, salt, sandstone, silica sand, and stone		3,449,433
Total value		$4,834,818

Napa County

Mineral production in Napa County in 1950 consisted of mercury, pumice, sand and gravel, and stone.

Nevada County

Mineral production in Nevada County in 1950 consisted of gold, sand and gravel, and silver.

Orange County

Product	Quantity	Value
Clay, short tons	23,611	$115,245
Natural gas, thousand cubic feet	25,452,000	2,709,000
Natural-gas liquids:		
Natural gasoline, barrels	2,631,398	7,863,000
Liquefied petroleum gases, barrels	216,193	360,000
Petroleum, barrels	33,918,000	65,048,000
Sand and gravel, short tons	1,484,362	1,244,818
Stone, short tons	140,945	152,078
Unapportioned: Peat and salt		47,597
Total value		$77,539,738

Placer County

Product	Quantity	Value
Gold, troy ounces	1,027	$35,945
Silver, troy ounces	483	437
Unapportioned: Clay, granite, sand and gravel, and stone		434,061
Total value		$470,443

Plumas County

Product	Quantity	Value
Copper, pounds	8,200	$1,706
Gold, troy ounces	346	12,110
Lead, pounds	100	14
Silver, troy ounces	122	110
Unapportioned: Barite, manganese ore, and sand and gravel		37,265
Total value		$51,205

Riverside County

Product	Quantity	Value
Clay, short tons	209,556	$562,501
Copper, pounds	1,300	270
Gold, troy ounces	59	2,065
Lead, pounds	45,900	6,196
Sand and gravel, short tons	1,600,014	1,419,371
Silver, troy ounces	865	783
Unapportioned: Cement, gypsum, iron ore, limestone, manganese ore, stone, and tungsten concentrates		11,687,726
Total value		$13,678,912

Mineral Production in California in 1950 by Counties—Continued

Sacramento County

Product	Quantity	Value
Clay, short tons	31,606	$34,817
Gold, troy ounces	98,152	3,435,320
Natural gas, thousand cubic feet	90,756,000	12,667,000
Sand and gravel, short tons	1,176,310	1,066,924
Silver, troy ounces	4,490	4,064
Unapportioned: Platinum and stone		182,457
Total value		$17,390,582

San Benito County

Product	Quantity	Value
Sand and gravel, short tons	300,648	$161,001
Unapportioned: Cement, clay, dolomite, mercury, petroleum, and stone		2,900,210
Total value		$3,061,211

San Bernardino County

Product	Quantity	Value
Clay, bentonite, and fuller's earth, short tons	24,763	$291,492
Copper, pounds	219,300	45,614
Gold, troy ounces	2,760	96,600
Lead, pounds	64,900	8,761
Limestone, short tons	335,481	955,203
Sand and gravel, short tons	1,262,043	1,032,234
Silver, troy ounces	13,103	11,859
Talc, short tons	60,701	1,360,267
Zinc, pounds	116,900	16,600
Unapportioned: Borates, bromine, calcium, chloride, cement, feldspar, granite, iron ore, lime, lithium minerals, perlite, petroleum, potash, pumice, quartz, salt, salt cake, sodium carbonate, stone, and tungsten ore		44,532,472
Total value		$48,351,102

San Diego County

Product	Quantity	Value
Gold, troy ounces	55	$1,925
Granite, cubic feet	22,113	83,605
Sand and gravel, short tons	2,016,162	2,850,624
Silver, troy ounces	12	11
Unapportioned: Clay, limestone, magnesium salts, peat, pyrophyllite, salt, and stone		753,073
Total value		$3,689,238

San Joaquin County

Product	Quantity	Value
Natural gas, thousand cubic feet	6,213,000	$868,000
Sand and gravel, short tons	1,509,960	1,350,898
Unapportioned: Clay, gold, silver, and stone		343,958
Total value		$2,562,856

San Luis Obispo County

Product	Quantity	Value
Petroleum, barrels	3,503,000	$9,003,000
Sand and gravel, short tons	431,859	290,363
Unapportioned: Natural gas, natural gasoline, liquefied petroleum gases, and stone		1,117,738
Total value		$10,411,101

San Mateo County

Mineral production in San Mateo County in 1950 consisted of cement, clay, limestone, magnesium salts, sand, and stone.

Mineral Production in California in 1950 by Counties—Continued

Santa Barbara County

Product	Quantity	Value
Natural gas, thousand cubic feet	18,031,000	$1,563,000
Natural gas liquids:		
Natural gasoline, barrels	630,418	1,864,000
Liquefied petroleum gases, barrels	240,098	383,000
Petroleum, barrels	29,592,000	59,784,000
Stone, short tons	37,762	38,262
Unapportioned: Clay, diatomite, and sand and gravel		4,862,697
Total value		$68,494,959

Santa Clara County

Clay, short tons	94,306	$71,806
Mercury, flasks	186	12,739
Sand and gravel, short tons	498,716	494,785
Stone, short tons	471,475	309,656
Unapportioned: Cement, limestone (shells), magnesite, and petroleum		12,925,312
Total value		$13,814,298

Santa Cruz County

Mineral production in Santa Cruz County in 1950 consisted of cement, clay, limestone, sand and gravel, and stone.

Shasta County

Copper, pounds	428,200	$89,066
Gold, troy ounces	7,775	272,125
Lead, pounds	375,500	50,692
Sand and gravel, short tons	310,800	171,245
Silver, troy ounces	41,817	37,846
Zinc, pounds	2,772,400	393,681
Unapportioned: Asbestos, platinum, pyrite, and stone		584,964
Total value		$1,599,619

Sierra County

Gold, troy ounces	17,617	$616,595
Silver, troy ounces	3,452	3,124
Total value		$619,719

Siskiyou County

Gold, troy ounces	13,808	$483,280
Lead, pounds	400	54
Pumice, short tons	17,458	61,273
Silver, troy ounces	1,802	1,631
Unapportioned: Limestone, manganese ore, platinum, sand and gravel, and stone		71,910
Total value		$618,148

Solano County

Natural gas, thousand cubic feet	67,270,000	$9,388,000
Stone, short tons	136,883	201,775
Total value		$9,589,775

Sonoma County

Stone, short tons	111,375	$131,688
Unapportioned: Mercury, petroleum, and sand and gravel		810,807
Total value		$942,495

Mineral Production in California in 1950 by Counties—Continued

Stanislaus County

Product	Quantity	Value
Sand and gravel, short tons	342,065	$279,788
Unapportioned: Clay, gold, natural gas, platinum, sandstone, and silver		317,465
Total value		$597,253

Sutter County

Mineral production in Sutter County in 1950 consisted of clay, natural gas, and sand and gravel.

Tehama County

Mineral production in Tehama County in 1950 consisted of sand and gravel.

Trinity County

Product	Quantity	Value
Gold, troy ounces	7,531	$263,585
Sand and gravel, short tons	3,720	3,046
Silver, troy ounces	676	612
Unapportioned: Manganese ore and stone		7,237
Total value		$274,480

Tulare County

Product	Quantity	Value
Gold, troy ounces	13	$455
Natural gas, thousand cubic feet	3,427,000	453,000
Sand and gravel, short tons	369,773	403,753
Silver, troy ounces	1	1
Unapportioned: Clay, petroleum, stone, and tungsten concentrates		287,993
Total value		$1,145,202

Tuolumne County

Product	Quantity	Value
Copper, pounds	1,000	$208
Gold, troy ounces	880	30,800
Lead, pounds	200	27
Silver, troy ounces	257	233
Stone, short tons	40,604	42,840
Unapportioned: Dolomite, lime, limestone, and sand and gravel		765,463
Total value		$839,571

Ventura County

Product	Quantity	Value
Natural gas, thousand cubic feet	60,543,000	$5,967,000
Natural-gas liquids:		
Natural gasoline, barrels	2,219,477	6,512,000
Liquefied petroleum gases, barrels	1,003,937	1,729,000
Petroleum, barrels	33,889,000	92,550,000
Sand and gravel, short tons	703,974	646,769
Unapportioned: Clay, gypsum, limestone, and stone		336,591
Total value		$107,741,360

Yolo County

Mineral production in Yolo County in 1950 consisted of mercury, natural gas, sand and gravel, and stone.

Yuba County

Product	Quantity	Value
Gold, troy ounces	65,026	$2,275,910
Silver, troy ounces	4,028	3,646
Unapportioned: Platinum, and sand and gravel		239,625
Total		$2,519,181

DIRECTORY OF PRODUCERS OF METALLIC AND NONMETALLIC MINERALS IN CALIFORNIA DURING 1950

(Producers of Natural Gas and Petroleum May Be Found in the Summary of Operations, California Oil Fields, July-Dec. 1950, vol. 36, no. 2, of the State Division of Oil and Gas.)

Nonmetallic Minerals

Asbestos (Tremolite)

Operator	Address	Location
Inyo County:		
Huntley Industrial Minerals, Inc.	P.O. Box 305, Bishop	Lone Pine
Shasta County:		
Loma Blanca Mines, Inc., Homer E. Fenn, Pres.	133 Katherine St., Salinas	Hazel Creek
Powhatan Mining Co.	Box 432, Auburn	Hazel Creek

Barite

Operator	Address	Location
Kern County:		
Halcrin Mining Co.	Box 278, Inyokern	Inyokern
Plumas County:		
Barium Products, Ltd.	Box 8-A, Newark	Almanor

7—64960

Nonmetallic Minerals—Continued

Borates

Operator	Address	Location
Inyo County:		
Pittsburgh Plate Glass Co., Columbia Chemical Division	Bartlett	Bartlett
United States Borax Co.	510 W. Sixth St., Los Angeles 14	Shoshone
Kern County:		
Pacific Coast Borax Co.	P.O. Box 9128 Station S, Los Angeles 5	Boron
San Bernardino County:		
American Potash and Chemical Corp.	3030 W. Sixth St., Los Angeles 54	Trona
West End Chemical Co.	608 Latham Square Bldg., Oakland 12	Westend

Bromine

Operator	Address	Location
Alameda County:		
Westvaco Chemical Div., Food Machinery & Chemical Corp.	405 Lexington Ave., New York 17, N. Y.	Newark
San Bernardino County:		
American Potash and Chemical Co.	3030 W. Sixth St., Los Angeles 54	Trona

Nonmetallic Minerals—Continued

Calcium Chloride

Operator	Address	Location
San Bernardino County:		
California Rock Salt Co.	2436 Hunter St., Los Angeles 21	Amboy
Desert Properties Co., Frank Thomas, Receiver (operated to 6-1-50)	374 Court St., Rm. 11, San Bernardino	Amboy
Hill Brothers Chemical Co.	2159 Bay St., Los Angeles 21	Amboy
National Chloride Company of America (Took possession from F. Thomas on 6-1-50)	354 S. Spring St., Los Angeles 13	Amboy

Carbon Dioxide Gas

Operator	Address	Location of well
Imperial County:		
Cardox Western, Inc.	151 N. Avenue 19, Los Angeles 31	Niland
Mendocino County:		
Caldri Ice Corp.	Old River Road, Hopland	Hopland

Nonmetallic Minerals—Continued

Cement

Operator	Address	Location
Calaveras County:		
Calaveras Cement Co.	315 Montgomery St., San Francisco 6	San Andreas
Kern County:		
Monolith Portland Cement Co.	3326 San Fernando Rd., Los Angeles 65	Monolith
Los Angeles County:		
Blue Diamond Corp.	1650 S. Alameda St., Los Angeles 54	Los Angeles
Riverside County:		
Riverside Cement Co.	621 S. Hope St., Los Angeles 14	Crestmore
San Benito County:		
Pacific Portland Cement Co.	417 Montgomery St., San Francisco 6	San Juan Bautista
San Bernardino County:		
California Portland Cement Co.	612 S. Flower St., Los Angeles 14	Colton
Riverside Cement Co.	621 S. Hope St., Los Angeles 14	Oro Grande
Southwestern Portland Cement Co.	1034 Wilshire Blvd., Los Angeles 14	Victorville
San Mateo County:		
Pacific Portland Cement Co.	417 Montgomery St., San Francisco 6	Redwood City
Santa Clara County:		
Permanente Cement Co.	Permanente	Permanente
Santa Cruz County:		
Santa Cruz Portland Cement Co.	324 Crocker Bldg., San Francisco 4	Davenport

Nonmetallic Minerals—Continued

Clay

Including producers of crude clay, fire clay, kaolin, bentonite, oil well drilling mud, and miscellaneous clay

Operator	Address	Location
Alameda County:		
California Pottery Co. (miscellaneous clay)	P.O. Box 68, Niles	Niles
Gladding, McBean & Co. (shale)	2901 Los Feliz Blvd., Los Angeles 26	Altamont, Livermore
Interlocking Roof Tile Co. (miscellaneous clay) and (shale)	Box 488, Niles	Niles
Kraftile Co. (miscellaneous clay)	Niles	Niles
Tesla Sand & Clay Co., G. G. Sanders (fire clay)	Mills Bldg., San Francisco	Tesla
Amador County:		
N. Clark & Sons Division, Pacific Clay Products Co. (fire clay)	P.O. Box 145, Sta. A, Los Angeles 31	Ione
Gladding, McBean & Co. (fire clay)	2901 Los Feliz Blvd., Los Angeles 26	Ione
Western Refractories Co. (fire clay)	P.O. Box 169, Ione	Ione
Calaveras County:		
California Pottery Co. (miscellaneous clay)	P.O. Box 68, Niles	Valley Springs
Pacific Clay Products Co. (fire clay)	Box 145, Sta. A, Los Angeles 31	Valley Springs
Contra Costa County:		
Port Costa Brick Works, C. G. Berg, Pres. (miscellaneous clay) and (shale)	401 Berry St., San Francisco 7	Port Costa
United Materials & Richmond Brick Co., Ltd. (miscellaneous clay) and (shale)	Box 7, Richmond	Richmond
Fresno County:		
Craycroft Brick Co. (miscellaneous clay)	P.O. Box 814, Fresno	Fresno
Humboldt County:		
Hindley Clay Products (miscellaneous clay)	3121 Essex St., Eureka	Cutten
Inyo County:		
Sierra Talc & Clay Co. (bentonite)	5509 Randolph Ave., Los Angeles 22	Olancha
Silicates Corp. (bentonite)	230 Park Ave., New York, N. Y.	Death Valley Junction
Imperial County:		
Radiant Minerals, Inc. (bentonite)	P.O. Box 359, Tacoma, Washington	El Centro

Nonmetallic Minerals—Continued

Clay—Continued

Including producers of crude clay, fire clay, kaolin, bentonite, oil well drilling mud, and miscellaneous clay

Operator	Address	Location
Kern County:		
American Mineral Co. (kaolin or China clay)	2770 E. Eighth St., Los Angeles 23	Cantil
Kernco Materials Co. (oil-well drilling mud)	P.O. Box 1202, Bakersfield	Muroc
Macco Corp., Drilling Mud Div. (oil-well drilling mud)	14409 S. Paramount Blvd., Paramount	Rosamond
McKittrick Mud Co. (oil-well drilling mud)	Box 356, McKittrick	McKittrick
Mojave Corp. (oil-well drilling mud)	P.O. Box 174, Los Nietos	Muroc
Los Angeles County:		
Angulo Tile Co. (miscellaneous clay)	19044 Kittridge St., Reseda	Reseda
Atkinson Brick Co. (miscellaneous clay)	13633 Central Ave., Los Angeles 2	Los Angeles
Atlas Sewer Pipe Co. (miscellaneous clay) and (adobe)	10009 S. Painter St., Whittier	Whittier
J. C. Booth (miscellaneous clay)	1775 Stanford Ave., Santa Monica	Santa Monica
Builders Brick Co. (miscellaneous clay)	P.O. Box 266, Gardena	Compton
Castaic Brick Co. (miscellaneous clay) and (shale)	Castaic	Castaic
Davidson Brick Co. (miscellaneous clay)	4701 Floral Dr., Los Angeles 22	Los Angeles
Gladding, McBean & Co., Tropico, L.A. & S.M. Plants (miscellaneous clay)	2901 Los Feliz Blvd., Los Angeles 26	Tropico, Los Angeles, Santa Monica, and Pico
Higgins Brick & Tile Works (miscellaneous clay)	P.O. Box 1125, Sta. A, Gardena	Moneta
Pacific Brick Co. (miscellaneous clay) and (shale)	P.O. Box 1125, Sta. A, Gardena	Santa Monica
Pacific Clay Products (miscellaneous clay)	Box 145, Sta. A, Los Angeles 31	Los Angeles and Los Nietos
Pomona Brick Co., S. Bernard Strona (miscellaneous clay) and (shale)	Ninth and Buena Vista, Pomona	Pomona
San Valle Tile Kilns (miscellaneous clay)	1258 N. Highland Ave., Los Angeles 38	Reseda
Simons Brick Co., Walter R. Simons (miscellaneous clay) and (shale)	1195 S. Boyle Ave., Los Angeles 23	Los Angeles
Southwest Brick Co. (miscellaneous clay) and (shale)	17601 S. Western Ave., Los Angeles	Los Angeles
Valley Brick & Supply Co. (miscellaneous clay) and (loam)	6151 Kester Ave., Van Nuys	Van Nuys
Marin County:		
McNear Brick Co. (miscellaneous clay) and (shale)	McNear Point, San Rafael	McNear Point

Orange County:		
El Toro Clay Co., I. P. Arold (Kaolin or China clay) and (fire clay)	7655 W. Second St., Downey, Los Angeles	El Toro
Gladding, McBean & Co. (fire clay)	2901 Los Feliz Blvd., Los Angeles 26	Irvine, Claymont, Prado
La Bolsa Tile Co. (miscellaneous clay)	R.F.D. 18404, Gothard St., Huntington Beach	Smeltzer
W. A. Schoeppe (Kaolin or China clay)	P.O. Box 101, El Toro	El Toro
Placer County:		
Gladding, McBean & Co. (fire clay)	2901 Los Feliz Blvd., Los Angeles 26	Lincoln
Lincoln Clay Products Co. (fire clay)	P.O. Box 367, Lincoln	Lincoln
Riverside County:		
Alberhill Coal & Clay Co. (fire clay) and (miscellaneous clay)	P.O. Box 14005, Barrington Sta., Los Angeles 24	Alberhill
Gladding, McBean & Co. (fire clay) and (miscellaneous clay)	2901 Los Feliz Blvd., Los Angeles 26	Sloan
Los Angeles Brick & Clay Products Co. (fire clay) and (miscellaneous clay)	1078 Mission Rd., Los Angeles 54	Alberhill
Pacific Clay Products (fire clay) and (miscellaneous clay)	Box 145, Sta. A, Los Angeles 31	Corona
Temescal Clay Co. (fire clay) and (miscellaneous clay)	2569 Clarendon Ave., Huntington Park	Temescal
Sacramento County:		
Cannon & Co. (fire clay) and (miscellaneous clay)	Box 802, Sacramento 4	Ben Ali and Michigan Bar
Harrison Fait (adobe)	1950 Howe St., North Sacramento	North Sacramento
Sacramento Brick Co. (miscellaneous clay)	1300 Front St., Sacramento 4	Sacramento
Western Refractories Co. (fire clay)	P.O. Box 169, Ione	Folsom
San Benito County:		
C. Hyde Lewis (bentonite)	Idria	Idria
San Benito Bentonite Co. (bentonite)	111 Brookside Ave., San Jose	Tres Pinos
San Bernardino County:		
Baroid Sales Div., National Lead Co. (bentonite)	830 Ducommun St., Los Angeles	Hector
Gladding, McBean & Co. (kaolin or China clay)	2901 Los Feliz Blvd., Los Angeles 26	Goff
Hancock Brick Yard, C. P. Hancock & Son (miscellaneous clay)	Box 421, Riverside	Highgrove
Inerto Co. (bentonite)	1489 Folsom St., San Francisco	Newberry
Marter Mining Co. (miscellaneous clay)	530 W. Sixth St., Los Angeles 14	Bryman
Southern California Minerals Co., W. K. Skeoch	320 S. Mission Rd., Los Angeles 33	Goff
San Diego County:		
La Jolla Canyon Clay Products (miscellaneous clay)	P.O. Box 712, La Jolla	La Jolla
Union Brick Co. (miscellaneous clay) and (shale)	P.O. Box 356, San Diego 9	Rose Canyon
San Joaquin County:		
Stockton Building Materials (miscellaneous clay)	711 S. Madison St., Stockton 4	Stockton
San Joaquin Brick Co.	P.O. Box 387, Stockton 4	Roberts Island

Nonmetallic Minerals—Continued

Clay—Continued

Including producers of crude clay, fire clay, kaolin, bentonite, oil well drilling mud, and miscellaneous clay

Operator	Address	Location
Santa Barbara County:		
McNall Building Materials (miscellaneous clay) and (shale)	P.O. Box 758, Santa Barbara	Santa Barbara
Santa Clara County:		
A. D. Bernal (miscellaneous clay)	1843 Naglee Ave., San Jose	San Jose
Gladding Bros. Mfg. Co. (miscellaneous clay) and (fire clay)	S. Third and Keyes Sts., San Jose 12	San Jose
Remillard-Dandini Co. (miscellaneous clay)	321 13th St., Oakland	San Jose
San Jose Brick & Tile, Ltd. (miscellaneous clay)	1440 Broadway, Rm. 701, Oakland	San Jose
Stanislaus County:		
Harry Chase (fire clay)	Box 37, Knights Ferry	Knights Ferry
Lester Raggio (fire clay)	Knights Ferry	Cooperstown
Sutter County:		
Gladding, McBean & Co. (miscellaneous clay)	2901 Los Feliz Blvd., Los Angeles 26	Nicolaus
Tulare County:		
S. P. Brick & Tile Co. (miscellaneous clay)	P.O. Box 568, Fresno	Exeter
Ventura County:		
Rocklite Products (shale)	1800 N. Ventura Ave., Ventura	Ventura
Shell Oil Co., Dent Clay Pit (oil-well drilling mud)	Shell Bldg., San Francisco	Ventura
Tidewater Associated Oii Co. (oil-well drilling mud)	79 New Montgomery St., San Francisco	Ventura

Nonmetallic Minerals—Continued

Coal

Operator	Address	Location
Amador County:		
American Lignite Products Co.	Ione	Ione

Diatomite (Diatomaceous Earth)

Operator	Address	Location
Los Angeles County:		
Great Lakes Carbon Corp., Dicalite Division	612 S. Flower St., Los Angeles 14	San Pedro
Santa Barbara County:		
Johns-Manville Products Corp.	22 E. 40th St., New York 16, N. Y.	Lompoc

Feldspar

Operator	Address	Location
San Bernardino County:		
Gladding, McBean & Co.	2901 Los Feliz Blvd., Los Angeles 26	Atolia

Nonmetallic Minerals—Continued

Granite

Operator	Address	Location
Fresno County:		
Superior-Academy Granite Co.	Box 68, Clovis	Academy
Lassen County:		
Greig Quarry, J. B. Wagender	805 Weatherlow St., Susanville	Susanville
Los Angeles County:		
H. A. Jones, et al.	215 W. Green St., Pasadena	Saugus
Placer County:		
Union Granite Co.	Rocklin	Rocklin
San Bernardino County:		
Flickinger & Welker	3851 W. 57th St., Los Angeles	Fontana
San Diego County:		
California Cut Stone & Granite Works	Railroad Ave. at Magnolia, South San Francisco	Vista
Fred B. Clemens	3460 Imperial Ave., San Diego 2	Suncrest
Crystal Black Quarry, John Stridsburg	Box 115, Escondido	Spooks Canyon (Escondido)
National Quarries	Rt. 2, Box 185, Escondido	Escondido and Fallbrook
Pacific Cut Stone & Granite Co.	414 S. Marengo Ave., Alhambra	Escondido
Southern California Granite Co.	3845 Imperial Ave., San Diego 13	Foster
Valley Granite Co., W. T. Blackwood	243 E. Fifth St., Escondido	Escondido

Nonmetallic Minerals—Continued

Gypsum

Operator	Address	Location
Alameda County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (output not included in production figures as gypsum is by-product of chemical process using minerals already included in state total.)	405 Lexington Ave., New York, N. Y.	Newark
Fresno County:		
Agricultural Mineral & Fertilizer Co., A. D. Sousa	P.O. Box 832, Los Banos	Los Banos
Edward Jones	P.O. Box 887, Dos Palos	Firebaugh
Valley View Gypsum Mine	Rt. 4, Box 221, Madera	Firebaugh
Imperial County:		
U. S. Gypsum	300 W. Adams St., Chicago 6, Ill.	Plaster City
Kern County:		
Carrisa Gypsum Mine, C. L. Fannin	Rt. 1, Box 7, Wasco	Wasco
H. M. Holloway	Box 310, Lost Hills	Lost Hills
Pacific Gypsum Co., W. D. Fowler	P.O. Box 563, Bakersfield	Conner
Western Gypsum Co.	773 Maple St., Wasco	McKittrick
Kings County:		
H. M. Holloway	Box 310, Lost Hills	Avenal
Riverside County:		
United States Gypsum Co.	300 W. Adams St., Chicago, Ill.	Midland
Utah Construction Co.	1 Montgomery St., San Francisco	Inca Siding
Ventura County:		
Monolith Portland Cement Co.	3316 San Fernando Rd., Los Angeles 65	Quatal Canyon

Nonmetallic Minerals—Continued

Iodine

Operator	Address	Location
Los Angeles County:		
Deepwater Chemical Co., Ltd.	Box 588, Compton	Compton
The Dow Chemical Co.	P.O. Box 245, Seal Beach	Long Beach, Venice, and Seal Beach

Lime, Limestone, and Shells

Operator	Address	Location
Alameda County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (producer of burnt lime)	405 Lexington Ave., New York, N. Y.	Newark
El Dorado County:		
California Rock & Gravel Co. (industrial limestone)	1800 Hobart Bldg., San Francisco	Newcastle
Diamond Springs Lime Corp. (producer of burnt lime), (industrial limestone), and (agricultural lime)	Box 409, Diamond Springs	Diamond Springs
El Dorado Limestone Co., J. H. Bell, Pres. (industrial lime)	Shingle Springs	Shingle Springs
Hughes-Vertin Lime Co. (producer of burnt lime), (industrial limestone), (agricultural lime), and (lime materials used in rough construction)	Box 231, Auburn	Newcastle
Kings County:		
Thompson Materials & Construction Co., Inc. (crushed limestone)	Bin J, Avenal	Avenal
Monterey County:		
Kaiser Aluminum & Chemical Corp. (producer of burnt lime) and (dolomite)	P.O. Box 1531, Salinas	Salinas

Riverside County:		
Riverside Cement Co. (industrial limestone)	621 S. Hope St., Los Angeles 14	Crestmore
San Benito County:		
Westvaco Chemical Div., Food Machinery & Chemical Corp. (dolomite)	405 Lexington Ave., New York, N. Y.	Hollister
San Bernardino County:		
Cal. Portland Cement Co. (producer of burnt lime) and (industrial limestone)	612 S. Flower St., Los Angeles 14	Colton
Riverside Cement Co. (industrial limestone)	621 S. Hope St., Los Angeles 14	Oro Grande
Victorville Lime Rock Co. (industrial limestone)	Box 548, Victorville	Victorville
West End Chemical Co. (producer of burnt lime) and (industrial limestone)	608 Latham Sq., Oakland 12	Westend
San Mateo County:		
California Aggregates (crushed limestone)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Pacific Portland Cement Co. (agricultural lime) and (shells)	417 Montgomery St., San Francisco	Redwood City
Santa Clara County:		
Bay Shell Co. (agricultural lime) and (shells)	1583 E. 14th St., Oakland	Alviso
Rhodes & Robinson (crushed limestone)	Box 325, Palo Alto	Stanford
Santa Cruz County:		
Pacific Limestone Prod. Co. (industrial limestone) and (agricultural lime)	445 Spring St., Santa Cruz	Santa Cruz
Santa Cruz Portland Cement Co. (industrial limestone)	327 Crocker Bldg., San Francisco	Davenport
Tuolumne County:		
Sonora Marble Aggregates Co. (industrial limestone)	356 Church St., San Francisco	Sonora
U. S. Lime Products Corp. (producer of burnt lime) (industrial limestone) and (agricultural lime)	1840 E. 25th St., Los Angeles 11	Sonora
Ventura County:		
Western Lime Products Co. (industrial limestone) and (agricultural lime)	12320 Ventura Ct., North Hollywood	Santa Susana

Nonmetallic Minerals—Continued

Lithia

Operator	Address	Location
San Bernardino County:		
American Potash & Chemical Corp.	3030 W. Sixth St., Long Angeles 54	Trona

Magnesia and Other Magnesium Compounds

Operator	Address	Location
Alameda County:		
Pabco Products, Inc. (carbonate)	1550 Powell St., Emeryville 8	Emeryville
Westvaco Chemical Division, Food Machinery & Chemical Corp. (oxide)	405 Lexington Ave., New York 17, N. Y.	Newark
Monterey County:		
Kaiser Aluminum & Chemical Corp. (oxide)	P.O. Box 1531, Salinas	Moss Landing
San Diego County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp. (chloride)	405 Lexington Ave., New York 17, N. Y.	Chula Vista
San Mateo County:		
Johns-Manville Products Corp. (carbonate)	22 E. 40th St., New York 16, N. Y.	Redwood City
Marine Magnesium Prod. Corp., R. E. Clarke (carbonate, hydroxide, and oxide)	South San Francisco	South San Francisco

Magnesite

Operator	Address	Location
Santa Clara County:		
Westvaco Chemical Division, Food Machinery & Chemical Corp.	405 Lexington Ave., New York 17, N. Y.	Red Mountain

Nonmetallic Minerals—Continued

Perlite

Operator	Address	Location
Contra Costa County:		
American Perlite Corp. (expanded)	26th and B Sts., Richmond	Richmond
Inyo County:		
United States Mining Corp. (crude)	6363 Wilshire Blvd., Los Angeles	Fish Springs
Los Angeles County:		
Coast Perlite Co., Inc. (expanded)	650 S. Clarence St., Los Angeles	Los Angeles
Great Lakes Carbon Corp. (expanded)	Torrance	Torrance
Pacific Rhyolex Corp. (expanded)	3941 Goodwin Ave., Los Angeles	Los Angeles
Panacalite Pacific, Inc. (expanded)	825 E. 60th St., Los Angeles 17	Los Angeles
Paramount Perlite Co., Inc. (expanded)	16236 S. Illinois, Paramount	Paramount
Redco, Inc. (expanded)	11831 Vose St., North Hollywood	North Hollywood
Wall-Tex Corp. (expanded)	P.O. Box 425, Sun Valley	Sun Valley
Marin County:		
Perolite Products Corp. (expanded)	Marinship, Sausalito	Sausalito
Napa County:		
Napa Perlite Co. (crude)	300 Montgomery St., San Francisco	St. Helena
Perlite Aggregates, Inc. (crude and expanded)	St. Helena	St. Helena
San Bernardino County:		
Nulite Insulated Homes, Inc. (expanded)	Box 216, Fontana	Fontana

Potash

Operator	Address	Location
San Bernardino County:		
American Potash and Chemical Co.	3030 W. Sixth St., Los Angeles 54	Trona

Nonmetallic Minerals—Continued

Pumice and Pumicite

Operator	Address	Location
Calaveras County:		
Lava Products Co., Robert Irvine (pumice)	3010 Colby St., Berkeley	Mokelumne Hill
Imperial County:		
Superlite Corp. (pumice)	P.O. Box 758, Calipatria	Calipatria
Inyo County:		
H. B. Jarvis (pumice)	P.O. Box 5, Little Lake	Little Lake
Desert Materials Corp. (pumice)	6363 Wilshire Blvd., Los Angeles	Inyokern
H. A. Van Loon (pumice)	Bishop	Bishop
Kern County:		
Calsilco Corp. (pumice, pumicite or volcanic ash)	445 S. Amalia St., Los Angeles	Red Rock Canyon
Madera County:		
California Industrial Mineral Co. (pumicite or volcanic ash)	Friant	Friant
Elmer Erickson (pumice)	Star Rt., Box 1, Fresno 7	Friant
Modoc County:		
Glass Mt. Brick Co. (pumice)	Box 10, Star Rt. 2, Tulelake	Glass Mountain
Glass Mt. Volcolite Co., H. W. Free (pumice)	Tionesta	Glass Mountain
Mono County:		
Insulating Aggregate Co., G. M. M. Grant (pumice)	Bishop	Laws
U. S. Pumice Supply Co. (pumice, scouring blocks)	5509 Randolph St., Los Angeles 22	Leevining
H. A. Van Loon (pumice)	Bishop	Benton
Napa County:		
Basalt Rock Co. (pumice)	P.O. Box 540, Napa	Napa
San Bernardino County:		
Western Talc Co. (pumicite or volcanic ash)	1901 E. Slauson Ave., Los Angeles 11	Yermo
Williams Bros. (pumice)	Star Rt. 1, Barstow	Hinckley

Operator	Address	Location
Siskiyou County:		
Boorman Pumice Products (pumice)	Tionesta	Glass Mountain
Glass Mt. Volcolite Co., H. W. Free (pumice, scouring blocks)	Tionesta	Glass Mountain
John Madsen (Skoria Star Brick Co.) (pumice, scouring blocks)	P.O. Box 711, Klamath Falls, Ore.	Glass Mountain
J. H. Scott Co. (pumice)	Merchants Exchange Bldg., San Francisco 4	Tennant
Shastalite Block Co. (pumice)	P.O. Box 914, Yreka	Cinder Cone Mtn.
Thompson Pumice Co. (pumice)	Tionesta	Glass Mountain

Pyrite

Operator	Address	Location
Shasta County:		
The Mountain Copper Co., Ltd., L. T. T. Kett, Jr., Mgr.	216 Pine St., San Francisco	Matheson

Salt

Operator	Address	Location
Alameda County:		
American Salt Co.	341 Broadway, San Francisco 11	Mt. Eden
Leslie Salt Co.	505 Beach St., San Francisco 11	Newark and Mt. Eden
Morton Salt Co.	120 S. La Salle St., Chicago, Ill.	Newark
Oliver Bros. Salt Co.	Mt. Eden	Mt. Eden
Monterey County:		
Monterey Bay Salt Works, E. C. Vierra, Mgr.	Box 43, Moss Landing	Moss Landing
Orange County:		
Western Salt Co.	P.O. Box 149, San Diego 12	Newport Beach
San Bernardino County:		
California Salt Co.	2436 Hunter St., Los Angeles 21	Amboy
Reeder Salt Co.	845 El Centro Ave., South Pasadena	Danby Dry Lake
San Diego County:		
Western Salt Co.	P.O. Box 149, San Diego 12	Chula Vista

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous

Under the heading of "miscellaneous stone" are four divisions—crushed rock, grinding mill pebbles, paving blocks, and sand and gravel. Crushed rock includes crushed rock that is used in macadam, ballast, and for concrete; also rock used for rubble and riprap.

NOTE—The California State Highway Commission, the various counties, cities, U. S. Engineers, U. S. Bureau of Reclamation, U. S. Forest Service, U. S. National Park Service, and U. S. Bureau of Public Roads produce both crushed rock and sand and gravel in various places in the state used in construction and maintenance of highways, but not specified in this listing.

Operator	Address	Location
Alameda County:		
Bell Sand & Gravel, Stanley L. and Anna L. Bell (sand and gravel)	P.O. Box 282, Irvington	Irvington
California Rock & Gravel Co. (sand and gravel)	1800 Hobart Bldg., San Francisco	Livermore
Heafey-Moore Co., Div. Gallagher & Burk, Inc. (crushed rock—macadam, fill rock, ballast)	6900 Mountain Rd., Oakland	Oakland
Inland Aggregates Co., Inc. (sand and gravel)	P.O. Box 236, Niles	Niles
Henry J. Kaiser Co. (sand and gravel, crushed rock)	Kaiser Bldg., 1924 Broadway, Oakland	Radum and Niles
Leslie Salt Co. (riprap)	505 Beach St., San Francisco	Newark
Niles Quarry Co. (crushed rock, fill rock)	Box 507A, 4061 Highland Blvd., Niles	Niles
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Eliot and Centerville
San Leandro Rock Co. (crushed rock, fill rock)	1575 Lake Chabot Rd., San Leandro	Lake Chabot
W. C. Thompson Inc. (Concrete Materials Co.) (sand and gravel)	1401 Illinois St., San Francisco	Pleasanton
A. C. Zaro (sand and gravel)	Box 323, Pleasanton	Pleasanton
Butte County:		
Butte Creek Rock Co. (sand and gravel)	Centerville Rd., Chico	Chico
Henry J. Kaiser Co. (sand and gravel, crushed rock—macadam, ballast, rubble, riprap, etc.)	1924 Broadway, Oakland	Oroville
Kemen Gravel Pit, C. J. Kemen (sand and gravel)	Paradise	Paradise
Roy Mathews Gravel Plant (sand and gravel)	Rt. 1, Box 23, Gridley	Gridley
Calaveras County:		
Neilsen Sand & Gravel Co. (sand and gravel)	Box 14, San Andreas	San Andreas
Colusa County:		
Cortina Sand, Gravel and Silt; Gene Godin (sand and gravel)	Colusa	Colusa

Contra Costa County:		
Alves Quarry (crushed rock, fill rock)	P.O. Box 97, Pittsburg	Pittsburg
Antioch Sand Co. (sand and gravel)	1806 30th Ave., San Francisco 22	Antioch
Basalt Rock Co. (sand and gravel)	Eighth and River Sts., Napa	Antioch
Blake Bros. Anson Blake (crushed rock, ballast, riprap)	Box 1002, Richmond	Point Richmond
Henry J. Kaiser Co. (sand and gravel, crushed rock)	1924 Broadway, Oakland	Antioch
Marchio Sand Co. (molding sand)	Antioch	Antioch
Morris Sand Pit, Ben Morris (sand and gravel)	R.F.D. Box 100, Antioch	Antioch
Serra Bros. (crushed rock, fill rock)	R.F.D. Rt. 1, Box 355, Martinez	Walnut Creek
Del Norte County:		
John Burman & Sons (sand and gravel)	2750 Harrison Ave., Eureka	----------
El Dorado County:		
El Dorado Rock & Sand, Jerry Brown & Son (sand and gravel)	Rt. 2, Box 185W, Placerville	Placerville
Diamond Springs Lime Co. (crushed rock—macadam)	Diamond Springs	Diamond Springs
T. C. Nutt Quarry (flagstone)	Placerville	Placerville
Ralph C. Young (flagstone)	Rt. 3, Box 252, Placerville	Placerville
Fresno County:		
Atchison, Topeka & Santa Fe Railway Co. (ballast)	121 E. Sixth St., Los Angeles 14	Oakhurst, Piedra
Central Rock & Sand Co. (sand and gravel)	P.O. Box 425, Sanger	Sanger
L. D. Folsom (sand and gravel)	Coalinga	Coalinga
Herndon Rock Products Co. (sand and gravel, crushed rock)	410 Thorne St., P.O. Box 886, Fresno	Herndon
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Rockfield
Sharp & Fellows Construction Co. (crushed rock—macadam, ballast)	533 Central Bldg., Los Angeles 14	----------
Southern California Edison Co. (crushed rock)	Edison Bldg., Los Angeles 53	----------
Glenn County:		
E. B. Bishop & Edward Thomas dba Orland Sand & Gravel Co. (sand and gravel)	P.O. Box 469, Orland	Orland
Southern Pacific Co. (sand and gravel)	65 Market St., San Francisco	Wyo
Humboldt County:		
Eureka Sand & Gravel Co. (sand and gravel)	1920 Williams St., Eureka	Eureka
Kelly & McWhorter (sand and gravel)	P.O. Box 572, Fortuna	Eureka
Mercer Fraser Co., Inc., Essex & Fernbridge (sand and gravel)	Second and Commercial Sts., Eureka	Arcata & Fortuna
Northwestern Pacific R.R. Co. (sand and gravel)	San Rafael	Sequoia
Imperial County:		
Hensler Construction Co. (sand and gravel)	7550 Wheetland Ave., Sun Valley	----------
Rancho Construction Co. (sand and gravel)	Box 1328, Brawley	Brawley
Yuma Sand and Gravel Co. (sand and gravel)	1144 W. Eighth St., Yuma, Ariz.	Winterhaven
Inyo County:		
Dolomite Products Co. (sand and gravel)	728 E. 29th St., Los Angeles 11	Lone Pine

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Kern County:		
C & H Materials Co. (sand and gravel)	Box 638, Oildale	Bakersfield
Edison Sand Co. (sand and gravel)	Box 395, Sta. A, Bakersfield	Bakersfield
Griffith Co. (sand and gravel)	Box 175, Sta. B, Bakersfield	Bakersfield
Hartman Concrete Materials (sand and gravel)	P.O. Box 1632, Bakersfield	Bakersfield and Maricopa
Kern Rock Co., Ltd. (sand and gravel)	P.O. Box 1697, Bakersfield	Kern River
Union Paving Co. (sand and gravel)	681 Market St., San Francisco 4	
Kings County:		
Thompson Materials & Construction Co., Inc. (crushed rock)	Bin J, Avenal	Avenal
Lake County:		
Lange Bros. Sand and Gravel Plant, H. Lange & A. Lange (sand and gravel)	Lakeport	Kelseyville
Lassen County:		
Grayson Concrete & Materials (sand and gravel)	1512 Fourth St., Susanville	Susanville
Los Angeles County:		
Arrow Rock Co. (sand and gravel)	11670 Wicks St., Sun Valley	Monrovia and Roscoe
A.T. & S.F.R.R., I. L. Hibbard, Gen. Mgr. (ballast)	121 E. Sixth St., Los Angeles 14	Forbes
Azusa Rock & Sand Co. (sand and gravel, crushed rock)	P.O. Box 575, Azusa	Azusa
Richard R. Ball (sand and gravel, filter sand)	Box 96, Walteria	Walteria
Blue Diamond Corp., Ltd. (sand and gravel)	P.O. Box 2678 Term. Annex Sta., Los Angeles 54	El Monte and Roscoe
Wm. J. Bonfield (decomposed granite)	2008 Laurel Canyon Rd., Los Angeles 46	Hollywood
California Materials Co. (sand and gravel)	P.O. Box 110, Whittier	Whittier
Chandler Sand & Gravel, L. Chandler (sand and gravel)	Box 295, Lomita	Lomita
City Rock Co. (sand and gravel, crushed rock)	P.O. Box 8, Sunland	Sunland
Connolly Pacific Co. (riprap)	1925 Water St., Long Beach	Santa Catalina Island
Consolidated Rock Products Co. (sand and gravel, crushed rock)	Box 2950 Terminal Annex or 2730 S. Alameda St., Los Angeles	Los Angeles, Azusa, Roscoe, Monroe, Monrovia, Baldwin Park, and North Hollywood
Gordon Transfer Co. (sand and gravel)	907 Main St., El Segundo	El Segundo
Graham Bros., Inc. (sand and gravel)	5500 N. Peck Rd., El Monte	El Monte
Granite Materials Co. (sand and gravel, decomposed granite)	12455 Wicks St., North Hollywood	Roscoe
Hanawalts (crushed rock, sand and gravel)	Box 187, La Verne	Pomona

Lindauer Corp. (sand and gravel)	Box 337, La Habra	La Habra
Livingston Truck & Materials Co. (decomposed granite)	3366 Cherry St., Long Beach 7	Rolling Hills
Los Angeles Decomposed Granite Co. (decomposed granite)	Box 39, Montebello	Montebello
E. J. MacArthur Co. (sand and gravel)	Rt. 1, Box 149-E, Saugus	Lang
Wm. R. Magoffin dba Caswell & Co. (sand and gravel)	2357 E. Slauson Ave., Los Angeles 58	
Manning Bros. Rock & Sand Co. (sand and gravel, crushed rock)	P.O. Box C, Irwindale	Irwindale
Miller Bros. Truck Co. (sand and gravel)	3451 Randolph St., Huntington Park	Huntington Park
Osborn Co. (sand and gravel)	2300 Edgecliff Lane, Pasadena	Pasadena
Owl Rock Products Co. (sand and gravel)	420 S. Alameda St., Compton	Monrovia
Pacific Rock & Gravel Co. (sand and gravel)	P.O. Box 30, Arrow Highway, Monrovia	Monrovia
Walter Ranson (sand and gravel)	3467 Greenfield Ave., Los Angeles 34	
Santa Catalina Island Co. (riprap)	Box B-2, Avalon	Santa Catalina Island
Edward Sidebotham & Sons, Inc. (sand and gravel)	South End Penn Ave., Lomita	Lomita
Sierra Rock Products (sand and gravel)	P.O. Box 216, Temple City	Temple City
Sparks & Mundo Engineering Co. (sand and gravel)	2727 E. Washington Blvd., Los Angeles	
Marin County:		
Basalt Rock Co. (crushed rock, riprap)	Eighth and River Sts., Napa	McNear Point
Hutchinson Co. (crushed rock-macadam, rubble, riprap)	7360 Schmidt Lane, El Cerrito	San Rafael
Marin Gravel Co. (sand and gravel)	Box 11, Point Reyes Station	Point Reyes
Mariposa County:		
Geo. P., J. G., and E. C. Greenamger (sand and gravel)	Mariposa	Mariposa
Mendocino County:		
John Freitas, Ukiah Gravel & Cement Co. (sand and gravel)	P.O. Box 187, Ukiah	Ukiah
E. Walsh and M. Ford (sand and gravel)	Box 74, Ukiah	Ukiah
Merced County:		
Cressy Sand and Gravel Plant, Vernon Lustre (sand and gravel)	Rt. 2, Box 360, Merced	Cressey
Los Banos Gravel Co. (sand and gravel)	P.O. Box 1111, Los Banos	Los Banos
River Rock Co. (sand and gravel)	20 E. 15th St., Merced	Merced
Turlock Rock Co. (sand and gravel)	P.O. Box 548, Turlock	Ballico
Modoc County:		
Moyer Gravel Co. (sand and gravel)	P.O. Box 25, Alturas	Alturas
Monterey County:		
Max Cozin (sand and gravel)	Box 9, Metz Rt., King City	King City
Del Monte Properties Co., C. S. Olmstead (sand and gravel, molding sand)	Del Monte	Pacific Grove
H. W. Kalar (sand and gravel)	Box 358, Marina	Marina
Monterey Sand Co. (sand and gravel, filter sand)	Box 928, Monterey	Seaside
M. J. Murphy, Inc. (sand and gravel)	P.O. Box 100, Carmel	Carmel
Pacific Coast Aggregates, Inc. (crushed rock)	400 Alabama St., San Francisco	Lapis and Prattco

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Napa County:		
Basalt Rock Co. (crushed rock-macadam, riprap)	Eighth and River Sts., Napa	Napa
Benson Gravel Plant (sand and gravel)	Angwin	Pope Valley
Orange County:		
I. P. Arnold (sand)	7655 E. Second St., Downey	Santa Ana
Geo T. Calhoon (sand)	P.O. Box 1741, Santa Ana	Anaheim
California Rock Co. (sand and gravel)	Rt. 3, Box 12111, Orange	Orange
Consolidated Rock Products Co. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Fullerton and Orange
Foster Sand & Gravel (sand and gravel)	915 S. Spadra Rd., Fullerton	Orange
A. E. Fowler & Sons (sand and gravel)	Rt. 3, 12705 Cambridge St., Orange	Orange
V. P. Fyre (molding sand)	1302 N. Flower St., Santa Ana	Santa Ana
Graham Bros., Inc. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	5500 N. Peck Rd., El Monte	San Juan Capistrano
D. D. Lawhead & Sons (decomposed granite)	Seal Beach	Seal Beach and Buena Park
McClelland & Son (sand and gravel)	151 Commercial Way, Costa Mesa	Anaheim
Sully-Miller Construction Co. (sand and gravel, crushed rock)	1500 W. Seventh St., Long Beach	El Modena
Placer County:		
Chevreaux Transit Mix (sand and gravel)	P.O. Box 65, Station A, Auburn	Auburn
Fredrickson Bros. (crushed rock)	1259 65th St., Emeryville	
Marchell & Miles Gravel Co. (sand and gravel)	Colfax	Colfax
Union Granite Co., Ruhkala Bros. (crushed rock-macadam, ballast, rubble, riprap, etc.)	Rocklin	Rocklin
Riverside County:		
A. T. & S. F. Ry. Co. (ballast)	121 E. Sixth St., Los Angeles 14	Box Springs
Guy F. Atkinson Co. (rubble, riprap)	1103 Hearwell Bldg., Long Beach	Bly Junction
Desert Rock Co. (sand and gravel)	Box 765, Indio	Indio
Geo. Herz & Co. (sand and gravel)	P.O. Box 191, San Bernardino	----------
Emil Johnson (crushed rock-macadam)	Rt. 2, Box 185, Escondido	Perris
Massey Rock & Sand Co. (sand and gravel)	Box 763, Indio	Indio
Owens-Illinois Glass Co. (glass sand)	320 California St., San Francisco	Corona
Palm Springs Bldrs. Supply Co. (sand and gravel)	490 Sunny Dunes Rd., Palm Springs	Whitewater

San Gorgonio Rock Products (sand and gravel)	1990 N. Hargrove St., Banning	Banning
Service Rock Co. (sand and gravel)	Box 309, Riverside	Riverside
Transit Mixed Concrete Co. (sand and gravel)	3464 E. Foothill Blvd., Pasadena	Corona
Valley Rock & Sand Corp. (sand and gravel)	Rt. 1, Box 198, San Jacinto	Moreno
Sacramento County:		
American River Sand & Gravel Co. (sand and gravel)	P.O. Box 156, Perkins	Perkins
Brighton Sand and Gravel Co. (sand and gravel)	P.O. Box 2604, Sacramento 10	Perkins
Del Paso Rock Products Co. (sand and gravel)	3490 Fair Oaks Blvd., Sacramento	Del Paso
Fair Oaks Gravel Co. (sand and gravel)	Rt. 1, Box 533, Illinois Ave., Fair Oaks 19	Fair Oaks
McGillivray Construction Co. (sand and gravel)	P.O. Box 873, Sacramento	Sacramento
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	400 Alabama St., San Francisco	Fair Oaks, Prattrock and American River
Perkins Gravel Co. (sand and gravel)	1846 37th St., Sacramento	Perkins
J. R. Reeves (sand and gravel, crushed rock-macadam, ballast, etc.)	P.O. Box 1072, Sacramento	Sacramento
San Benito County:		
Granite Rock Co. (crushed rock—macadam, ballast)	Box 151, Watsonville	Logan
Buzz Young, Sunnyslope Building Supply (sand and gravel)	Rt. 1, Box 50, Hollister	Hollister
San Bernardino County:		
A.T. & S.F. Ry. Co. (crushed rock, ballast)	121 E. Sixth St., Los Angeles	Newberry
Consolidated Rock Products Co. (sand and gravel, crushed rock—macadam, ballast, rubble, riprap, etc.)	2730 S. Alameda St., Los Angeles	Claremont
Fontana Gravel Co. (sand and gravel)	Fontana	Fontana
Fourth St. Rock Crusher (sand and gravel)	P.O. Box 469, San Bernardino	San Bernardino
Geo. Herz & Co. (sand and gravel)	P.O. Box 191, San Bernardino	San Bernardino
Holliday Rock Co. (sand and gravel)	P.O. Box 215, Upland	Upland and Colton
Redlands Gravel Co. (sand and gravel)	305 S. Buena Vista St., Redlands	Redlands
San Bernardino Rock & Gravel Co. (sand and gravel)	1910 W. Seventh St., San Bernardino	San Bernardino
Triangle Rock & Gravel Co. (sand and gravel)	P.O. Box 2098, San Bernardino	San Bernardino
Tri-City Rock Co. (sand and gravel)	Alabama St., Redlands	Redlands
San Diego County:		
Charles & Victor Arnell, Lakeside Sand Plant (sand and gravel)	Rt. 1, Box 10, Lakeside	Lakeside
Canyon Rock Co. (sand and gravel, crushed rock)	Box F, Hillcrest Sta., San Diego 3	San Diego
Caudell & Johnson (sand and gravel)	Box B, Hillcrest Sta., San Diego 3	Mission Valley, Poway Valley
Crystal Silica Co. (sand and gravel, filter sand)	717 E. 61st St., Los Angeles 1	Oceanside
Daley Corp. (sand and gravel)	Mission Valley & Ward Rd., San Diego 4	San Diego
Denton's Sand Plant, Edmond Denton (sand and gravel)	4166 Pepper Dr., San Diego 5	El Cajon

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
San Diego County—Continued		
H. G. Fenton Material Co., Inc. (sand and gravel)	1245 National Ave., San Diego 12	San Diego
Henry Gray (sand and gravel)	609 S. Hill St., Oceanside	Oceanside
Howard & Haskins (sand and gravel)	P.O. Box 81, Santee	Santee
Hubbard Molding Sand Co. (molding sand)	2700 Barnson Pl., San Diego 3	San Diego
Nelson & Sloan (sand and gravel)	Box 488, Chula Vista	Chula Vista
Carl Niemann (sand and gravel)	Box 52, Del Mar	Del Mar
Smith Contractors (sand and gravel)	Box 37, Cardiff	Cardiff
Valley Granite Co., (riprap)	243 E. Fifth St., Escondido	Escondido
Vista Cement Products, A. J. McFall (sand and gravel)	156 W. Vista Way, Vista	Vista
Woodward Sand Co., Arthur C. Woodward (sand and gravel)	Rt. 1, Box 250, San Diego 10	San Diego
San Joaquin County:		
Frank B. Marks & Sons (sand and gravel)	P.O. Box 668, Newman	Tracy
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Riverbank, Tracy, Kerlinger
Putnam Sand & Gravel Co. (sand and gravel)	P.O. Box 486, Modesto	Riverbank
P. F. Sievers, Mokelumne Pit (sand and gravel)	P.O. Box 24, Clements	Clements
Tracy Rock & Gravel Co. (sand and gravel)	2101 Weber St., Stockton	Tracy
Clyde Wood Co. (sand and gravel)	P.O. Box 599, Lodi	Clements
San Luis Obispo County:		
Guiton Molding Sand Co. (sand and molding sand)	Oceano	Oceano
Walter B. Roselip (sand and gravel)	Box 251, San Luis Obispo	Atascadero
San Mateo County:		
A. & B. Quarry (crushed rock—macadam, ballast, rubble, riprap, etc.)	P.O. Box 1037, Redwood City	Woodside
Brisbane Rock Co. (crushed rock—macadam, ballast, rubble, riprap, etc.)	P.O. Box 638, Brisbane	Brisbane
Rockaway Quarry, Inc. (sand)	340 Pine St., San Francisco	Rockaway Beach
Ken Royce, Inc. (crushed rock—macadam)	185 Bayshore Blvd., San Francisco	Rockaway Beach
Peter Sorenson (crushed rock—macadam, fill rock)	927 Arguello, Redwood City	Belmont
Santa Barbara County:		
H. G. Iliff & Son (sand and gravel)	Box 373, Santa Maria	Santa Maria
Southern Pacific Milling Co. (sand and gravel)	735 State St., Santa Barbara	Santa Maria

Santa Clara County:		
Henry W. Jensen (sand and gravel)	575 Apricot Way, Campbell	Campbell
Los Gatos Sand and Gravel Co. (sand and gravel)	P.O. Box 502, Los Gatos	Los Gatos
George Neary (crushed rock—macadam, fill rock)	Rt. 1, Box 604, Los Altos	Los Altos
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Coyote and Campbell, San Jose
A. J. Raisch Paving Co. (sand and gravel)	900 W. San Carlos St., San Jose	San Jose
Rhodes & Robinson, Stanford Quarry (crushed rock—macadam, riprap, fill rock)	Box 325, Palo Alto	Palo Alto
Western Gravel Corp. (sand and gravel)	Railroad and Kennedy Aves., Campbell	Campbell
Santa Cruz County:		
Henry J. Kaiser Co. (sand)	1924 Broadway, Oakland	Olympia
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Olympia
Santa Cruz Aggregate Co. (sand and gravel)	P.O. Box 485, Felton	Felton and Olympia
Shasta County:		
J. H. Hein Co. (sand and gravel)	P.O. Box 226, Redding	Redding
Oaks Sand, Gravel & Cement Products Co., (sand and gravel, crushed rock)	1737 Yuba St., Redding	Redding
Siskiyou County:		
John S. Jensen & M. N. Thompson (sand and gravel)	Box 836, Mount Shasta	Mount Shasta
Southern Pacific R.R. Co., Chief Engineer (slag and volcanic cinder)	Southern Pacific Bldg., San Francisco	Kegg
Solano County:		
Fredrickson Bros. (crushed rock, fill rock)	1259 65th St., Emeryville	
J. M. Nelson, Cordelia Quarry (crushed rock, macadam, riprap)	Cordelia	Cordelia
Parish Bros. (crushed rock—macadam, riprap)	Benicia	Benicia
Sonoma County:		
Basalt Rock Co. (sand and gravel, crushed rock, riprap, etc.)	Eighth and River Sts., Napa	Healdsburg
S. Cabrol (flagstone)	Rt. 1, Box 115, Glen Ellen	Glen Ellen
Gordenker Bros., (flagstone)	R.F.D. Box 112a, Glen Ellen	Glen Ellen
Thomas A. Graham (crushed rock—macadam)	Box 1, Occidental	Occidental
Hein Bros. Basalt Rock Co., Mark Hein, Pres., (crushed rock—macadam, ballast)	P.O. Box 162, Petaluma	Petaluma
Maxwell Bros. (sand and gravel)	1330 King St., Santa Rosa	Santa Rosa
Stanislaus County:		
Hughson Gravel Plant (sand and gravel)	P.O. Box 35, Hughson	Hughson
Johnson Bros. (sand and gravel)	Rt. 1, Box 1880, Modesto	Modesto
Frank B. Marks & Sons (sand and gravel)	P.O. Box 668, Newman	Newman
Putnam Sand & Gravel Co. (sand and gravel)	P.O. Box 486, Modesto	Modesto
C. Skove & J. Wychopen (sand and gravel)	222 Chestnut St., Turlock	Tuolumne River
Standard Rock Co. (sand and gravel)	Escalon	Escalon
H. Sykes (sand and gravel)	P.O. Box 626, Patterson	Patterson
Chas. D. Warner & Son, Inc. (sand and gravel)	1027 Waterford Rd., Modesto	Modesto

Nonmetallic Minerals—Continued

Sand, Gravel, and Stone, Miscellaneous—Continued

Operator	Address	Location
Tehama County:		
Baker Trucking Co. (sand and gravel, crushed rock-macadam, ballast, rubble, riprap, etc.)	Hamilton City	Hamilton City
Trinity County:		
Northwestern Pacific R. R. Co. (crushed rock, ballast)	San Rafael	Island Mountain
Tulare County:		
Middletons-Sequoia Rock Co. (sand and gravel)	P.O. Box 1468, Visalia	Visalia and Lemon Cove
Pacific Coast Aggregates, Inc. (sand and gravel, crushed rock)	400 Alabama St., San Francisco	Lindsay
Terminus Beach Rock Co. (sand and gravel)	P.O. Box 291, Lemon Cove	Lemon Cove
Tuolumne County:		
Beerman & Jones (sand and gravel, riprap)	P.O. Box 678, Sonora	Soulsbyville
Ventura County:		
Montalvo Rock Co. (sand and gravel)	Box 188, Montalvo	Montalvo
Santa Paula Rock Co. (sand and gravel)	P.O. Box 671, Santa Paula	Santa Paula
Saticoy Rock Co. (sand and gravel, crushed rock, macadam)	Box 970, Ventura	Saticoy-Ventura
Ventura Molding Sand Co., O. D. Messmore (molding sand)	P.O. Box 1808, Ventura	Ventura
Yolo County:		
Leroy Kerr (sand and gravel)	Box 34, Yolo	Yolo
J. Dudley Stephens (sand and gravel)	Box 79, Woodland	Esparto
Yuba County:		
Hallwood Sand & Gravel Co. (sand and gravel)	711 Wilkie Way, Yuba City	Marysville
Rice Bros. (sand and gravel)	P.O. Box 1489, Marysville	Marysville
Yuba River Sand Co. (sand and gravel)	Box 307, Marysville	Marysville

Nonmetallic Minerals—Continued

Sandstone

Operator	Address	Location
Monterey County:		
Carmel Stone quarry, A. L. Passadori (Carmelstone for building)	Box 185, Carmel	Carmel
Stanislaus County:		
W. E. Yeisley (sandstone flagstone for building)	Box 185, Jamestown	Cooperstown

Silica

Operator	Address	Location
Kern County:		
N. W. Sweetser (quartz)	Box 445, Rosamond	Rosamond
Mariposa County:		
Kaiser Aluminum & Chemical Corp. (quartz)	Permanente	Le Grande
Monterey County:		
Del Monte Properties (ground silica sand)	Del Monte	Pacific Grove
Owens-Illinois Glass Co. (glass sand)	P.O. Box 359, Pacific Grove	Pacific Grove
Riverside County:		
Owens-Illinois Glass Co. (glass sand)	P.O. Box 298, Corona	Corona
San Bernardino County:		
Mineral Materials Co., C. W. Dunton, Mgr. (quartzite)	1145 Westminster Ave., Alhambra	Oro Grande

Nonmetallic Minerals—Continued

Slate

Operator	Address	Location
El Dorado County:		
Pacific Minerals Co., Ltd. (granules, filler)	337 10th St., Richmond	Chili Bar
Inyo County:		
James F. Nikalous (facing, granules, filler)	109 S. Main St., Bigpine	Keeler
Red Slate Quarry, A. J. Carothers (facing)	Lone Pine	Lone Pine
Mariposa County:		
Mt. Bullion Slate Quarry, John C. Kingman (facing)	Mt. Bullion	Mt. Bullion
J. W. Turpin (facing)	Box 50, Coulterville	Coulterville

Soda

Operator	Address	Location
Inyo County:		
Kaiser Aluminum & Chemical Co. (soda ash)	Kaiser Bldg., 1924 Broadway, Oakland	Lone Pine
Natural Soda Products Co. (soda ash, Trona)	405 Montgomery St., San Francisco 4	Keeler
Pittsburgh Plate Glass Co., Columbia Chemical Division (soda ash, trona)	Bartlett	Bartlett
San Bernardino County:		
American Potash & Chemical Co. (soda ash, salt cake)	3030 W. Sixth St., Los Angeles 54	Trona
West End Chemical Co. (soda ash)	608 Latham Sq. Bldg., Oakland 12	Westend

Sulfur

Operator	Address	Location
Los Angeles County:		
Hancock Chemical Co. (sulfur recovered from petroleum refinery gasses)	P.O. Box 810, Long Beach 1	Wilmington
Inyo County:		
Crater Group, R. E. Kitching	310 Pacific St., Bakersfield	Bigpine

Nonmetallic Minerals—Continued

Talc, Soapstone, and Pyrophyllite

Mine	Operator	Address	Location
El Dorado County (soapstone)	Pacific Minerals Co., Ltd.	337 10th St., Richmond	Shingle Springs
Inyo County:			
Longhorn (talc)	W. H. Anderson	Box 733, Big Pine	Eureka Valley
Imus (pyrophyllite)	Blue Star Mines, Ltd. (purchased from T. O. Imus April 15, 1950)	667 S. Anderson St., Los Angeles 23	Fish Springs
Alberta, Florence, & White Mt. (talc)	William Bonham	Lone Pine	Keeler
Big Talc (talc)	Louise Grantham et al.	809 E. Sixth St., Ontario	Shoshone
Imus (pyrophyllite)	T. O. Imus (sold to Blue Star Mines, Inc., April 15, 1950)	Bigpine	Bigpine
Gold Belt Group (talc)	Roy Hunter	Lone Pine	Gold Belt
	Knight and Myers	Bigpine	Bigpine
Eclipse & Warm Springs (talc)	Kennedy Minerals Co., Inc.	2552 E. Olympic Blvd., Los Angeles	Bigpine
Alliance & Silver Dollar (talc)	George W. Koest	Box 75, Darwin	Darwin
Eureka (talc)	James F. Nikolaus	109 S. Main St., Bigpine	Saline Valley
Gray Eagle (talc)	G. P. Rogers	Box 39, Bigpine	Bigpine
Frisco, Talc City, Trinity, Panamint, Tecopa (talc)	Sierra Talc & Clay Co.	5509 Randolph St., Los Angeles	Keeler, Shoshone, and Tecopa
Los Angeles County:			
Dr. Katz (soapstone)	Dr. Leon Katz	3239 Weldon Ave., Los Angeles	Acton
Mono County (pyrophyllite)	Charles Brown	Laws	Laws
Pacific (pyrophyllite)	Huntley Industrial Minerals, Inc.	P.O. Box 305, Bishop	Laws
San Bernardino County:			
Yucca Grove (talc)	Desert Talc & Clay Co.	Pomona	Yucca Grove
Victor (pyrophyllite)	Mineral Materials Co., Ltd.	1145 Westminster Ave., Alhambra	Victorville
Ibex, Monark, Silver Lake (talc)	Sierra Talc & Clay Co.	5509 Randolph St., Los Angeles	Shoshone & Baker
Calmasil, Excelsior, & Superior (talc)	Southern California Minerals Co., W. S. Skeoch	320 S. Mission Rd., Los Angeles	Ivanpah, Shoshone, and Baker
(talc)	Western Talc Co.	1901 E. Slauson Ave., Los Angeles	Tecopa
San Diego County:			
Mathews (pyrophyllite)	Pioneer Pyrophyllite Products	P.O. Box 686, Chula Vista	Del Mar

Metallic Minerals

Antimony

Mine	Operator	Address	Location
Riverside County:			
Mt. Antimony	R. A. Mattey	Box 369, Corona	Corona

Chromite

Mine	Operator	Address	Location
Butte County:			
Lambert	Helmke, Thomas, & Janssen	320 Market St., San Francisco	Magalia

Copper

Principal copper producers in California in 1950. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location
Calaveras County:			
Penn	Penn Chemical Company	Campo Seco	Campo Seco
Inyo County:			
Darwin Group	Anaconda Copper Mining Company	25 Broadway, New York, N. Y.	Darwin
Pine Creek	United States Vanadium Corp.	1354 Second Ave., New York, N. Y.	Bishop
Shoshone Group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa
San Bernardino County:			
Bagdad Chase—Roosevelt	Donald F. Love	P.O. Box D, Ludlow	Ludlow
New Trail	Alloy Mining Company	2320 N. Alameda St., Compton	Nipton
Shasta County:			
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Ingot
Bully Hill Smelter	M. C. & M. D. Jordan	504 West Park St., Butte, Mont.	Shasta Dam
Hornet—Richmond	Mountain Copper Co., Ltd.	216 Pine St., San Francisco	Matheson

Metallic Minerals—Continued

Gold

Principal gold producers in California out of a total of 186 placer operators and 243 lode mines in 1950. (Not less than 100 ounces.)

Mine	Operator	Address	Location
Amador County:			
Kennedy Tailings (tailings dump)	Jackson & Austin Milling Company	1120 24th St., Sacramento	Jackson
Old Eureka (lode gold mine)	Central Eureka Mining Company	Sutter Creek	Sutter Creek
Butte County:			
Butte Unit (dredge-bucket line)	Yuba Consolidated Gold Fields	351 California St., San Francisco	Oroville
Kister Dredge (dredge-bucket line)	Gold Hill Dredging Company	311 California St., San Francisco	Oroville
Calaveras County:			
Alta	Alta Mining Company	P.O. Box 41, Altaville	Altaville
Bishop (Malispina property) (dragline)	Modrell & Warren	Murphys	Vallecito
Blackstone (lode gold mine)	Blackstone Mine	5208 Barrett Ave., Richmond	West Point
Centennial (New Champion) (lode gold mine)	New Champion Mining Company	West Point	West Point
Penn (zinc mine)	Penn Chemical Company	Campo Seco	Campo Seco
*Royal (lode gold mine)	Frank Tower et al.	Copperopolis	Hodson
El Dorado County:			
Alhambra (lode gold mine)	Alhambra Gold Mine Corporation	Georgetown	Kelsey
David property (dragline)	Lord & Bishop	Box 812, Sacramento	Greenwood
Grit (lode gold mine)	Liddicoat Gold Mining Company	Rt. A, Box 27, Greenwood	Greenwood
Hazel Creek (lode gold mine)	Hazel Creek Mine	Box 302, Pollock Pines	Pollock Pines
River Pine Dredge (dragline)	River Pine Mining Co., Ltd.	141 Battery St., San Francisco	Diamond Springs
Shaw & Clayton (lode gold mine)	Volo Mining Company	464 Main St., Placerville	Placerville
Spanish Bar (dragline)	Inter-American Enterprises, Ltd.	1301 E. El Camino Ave., Sacramento	Georgetown
Fresno County:			
Rockfield Plant (dryland dredge, commercial gravel plant)	Pacific Coast Aggregates, Inc.	400 Alabama St., San Francisco	Friant
Imperial County:			
Cargo Muchacho (lode gold mine)	Holmestake Mining Co., Inc.	P.O. Box 308, Winterhaven	Winterhaven

*Ore mined prior to 1950

Metallic Minerals—Continued

Gold—Continued

Mine	Operator	Address	Location
Inyo County:			
Darwin group (zinc-lead mine)	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin
Goldbottom Tailings (tailings dump)	Louis Warnken, Jr.	Darwin	Trona
Reward (Brown Monster) (lode gold mine, lead mine)	T. L. & D. Bright and J. F. Nickalous	Independence	Manzanar
Shoshone group (lead mine)	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa
Skidoo (lode gold mine)	D. B. Harris, et al.	P.O. Box 4, Trona	Trona
Kern County:			
C & H Plant (dragline, commercial gravel plant)	C & H Materials Company	P.O. Box 638, Oildale	Bakersfield
Cactus Queen (lode gold mine)	Burton Bros., et al.	Rosamond	Rosamond
Elephant-Eagle (includes Hope) (lode gold mine)	Geo. Stemwedel, H. Flory & Roy Ryan	Rosamond, and Box 4, Trona	Mojave
Standard (lode gold mine)	Standard Hill Mines	Mojave	Mojave
Tropico (lode gold mine)	Burton Mines, Inc., et al.	Rosamond	Rosamond
Whitmore (gold-silver mine)	Lessees of Whitmore Mines, Inc.	Mojave	Mojave
Yellow Aster (lode gold mine)	King Soloman Lease	Box 101, Johannesburg	Randsburg
Los Angeles County:			
Consolidated Rock Plant (dryland dredge, commercial gravel plant)	Consolidated Rock Products Co.	2730 S. Alameda St., Los Angeles	Azusa
Madera County:			
Chalfant Ranch (suction dredge)	Howell Brothers	P.O. Box 73, Raymond	Raymond
Wishon & Watson property (suction dredge)	Fred Williams & Fred Santoni	Rt. 1, Box 591-C, Fresno	Friant
Mariposa County:			
Diltz Oro Grande (lode gold mine)	Diltz Oro Grande Mining Co. and John Fulham	441 21st St., Merced and Box 228, Mariposa	Mariposa
Dredge No. 3 (dragline)	Thurman & Wright	235 Montgomery St., San Francisco	Hornitos
Marble Springs (lode gold mine)	Glenn-Steintorf Co.	3134 E. 10th St., Oakland	Bower Cave
Nutmeg (lode gold mine)	Permit Mining Corporation	Midpines	Mariposa
Merced County:			
Snelling Dredge (dredge bucket line)	Snelling Gold Dredging Co.	Snelling	Snelling

Mono County:			
Sarita & Pittsburg (lode gold mine)	Sarita Milling Co.	Bridgeport	Masonic
Nevada County:			
Ancho & Erie group (lode gold mine)	Ancho Erie Mining Co.	401 Second St., San Francisco	Graniteville
Eastman (dryland dredge)	Crescent Pacific Mining Co.	260 California St., San Francisco	North Columbia
Empire Star group (lode gold mine)	Empire Star Mines, Ltd.	P.O. Box 1027, Grass Valley	Grass Valley
French Bar (dryland dredge)	R. L. Forkner	P.O. Box 145, Grass Valley	French Corral
Idaho & Brunswick Units (lode gold mine)	Idaho Maryland Mines Corp.	P.O. Box 1028, Grass Valley	Grass Valley
Relief Hill (hydraulic mine)	Western Gold, Inc. & Lessees	200 Clay St., San Francisco	North Bloomfield
Waukashau (hydraulic mine)	Mellott & Mellott	Graniteville Star Route, Nevada City	North Bloomfield
Placer County:			
Lyons & Matherly Dredge (suction dredge)	Frank Lyons & E. B. Matherly	1377 Norton St., Oroville	Loomis
Mary Len (lode gold mine)	Mary Len Mine & A. H. L. Mining Co.	P.O. Box 240, Newcastle	Penryn
Sacramento County:			
Capital Dredges (dredge bucket line)	Capital Dredging Co.	351 California St., San Francisco	Folsom
Cosumnes Dredge (dredge bucket line)	Cosumnes Gold Dredging Co.	465 California St., San Francisco	Sloughhouse
Fair Oaks, Gravel Plant (dragline)	Fair Oaks Gravel Co.	Rt. 1, Box 533, Fair Oaks	Fair Oaks
General Dredge (dragline)	General Dredging Co.	Natomas	Natoma
Haggin Gravel Plant (dryland dredge, commercial gravel plant)	Mrs. C. M. Craig	2457 Portola Way, Sacramento	Brighton
Natomas (dredge bucket line)	Natomas Company	P.O. Box 1197, Sacramento	Folsom
Van Vleck property (dragline)	Mountain Gold Dredging Co.	Sutter Creek	Michigan Bar
San Bernardino County:			
Bagdad Chase-Roosevelt (lode gold mine, copper mine)	Donald F. Love	P.O. Box D, Ludlow	Ludlow
Pioneer group (lode gold mine)	Rhodes, Kirkland, Ralston & Ralston	P.O. Box 18, Johannesburg	Johannesburg
Super Mold (dryland dredge)	Surcease Mining Co.	214 30th St., Sacramento	Atolia
San Joaquin County:			
Lower Comanche Dredge (dredge bucket line)	Gold Hill Dredging Co.	311 California St., San Francisco	Camanche
Shasta County:			
Afterthought (zinc mine)	Coronado Copper & Zinc Company	1206 Pacific Mutual Bldg., Los Angeles	Ingot
Battams property (dragline)	Roy S. Olson	1178 Walnut Ave., Redding	Redding
Thurman Dredge (dredge-bucket line)	Thurman Gold Dredging Company	235 Montgomery St., San Francisco	Redding

Metallic Minerals—Continued

Gold—Continued

Mine	Operator	Address	Location
Sierra County:			
Alaska (lode gold mine)	H. L. Sorensen	685 Sixth St., San Francisco	Pike
Brush Creek (lode gold mine)	Best Mines Co. & Brush Creek Mine	Downieville	Downieville
Irelan (lode gold mine)	George Hyland	6105 Castle Dr., Oakland	Alleghany
Kate Hardy (lode gold mine)	John O'Donnell	Alleghany	Forest
Original Sixteen to One (lode gold mine)	Original Sixteen to One Mine, Inc.	1611 Russ Bldg., San Francisco	Alleghany
Red Star (Yellow Jacket) (lode gold mine)	Yellow Jacket Cons. Gold Mines, Ltd.	120 Chester Ave., Bakersfield	Alleghany
Siskiyou County:			
Indian Creek Placer (dredge-bucket line)	French Gulch Dredging Co.	940 Russ Bldg., San Francisco	Fort Jones
Quartz Hill (lode gold mine)	Mill Creek Company	564 Market St., San Francisco	Scotts Bar
Reeves Ranch Dredge (dredge-bucket line)	Reeves Ranch Dredging Co.	Happy Camp,	Happy Camp
Siskiyou Unit (dredge-bucket line)	Yuba Consolidated Gold Fields	351 California St., San Francisco	Callahan
Star (dragline)	Emmor W. Little	P.O. Box 584, Yreka	Deadwood
Stanislaus County:			
Dredge No. 4 (dredge-bucket line)	La Grange Gold Dredging Co.	1805 Mills Tower, San Francisco	La Grange
Trinity County:			
Barthol-Jacobs property (Red Hill) (hydraulic mine)	Goldfield Consolidated Mines Co.	1 Montgomery St., San Francisco	Junction City
V. B. Bennett Dredge (dragline)	Terminal Truck Service	211 N. 16th St., Sacramento	Helena
Fairview Placers (dredge-bucket line)	Fairview Placers	Lewiston	Minersville
Tuolumne County:			
Eagle Shawmut Mill (terminal clean-up)	W. R. Leedom	P.O. Box 1, Chinese Camp	Chinese Camp
Fidelity (pocket mine)	Fidelity Mine	Columbia	Columbia
Ford (pocket mine)	Ralph & Jo Tapley	P.O. Box 356, Columbia	Columbia
Yuba County:			
Browns Valley group (lode gold mine)	Empire Star Mines, Ltd.	P.O. Box 1027, Grass Valley	Browns Valley
Yuba Unit (dredge-bucket line)	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton

Metallic Minerals—Continued

Iron

Mine	Operator	Address	Location
Riverside County:			
Eagle Mountain	Kaiser Steel Corp.	P.O. Box 217, Fontana	Desert Center
San Bernardino County:			
Bessemer	Edward Hedstrom	544 Merritt Ave., Oakland	Lucerne Valley
Vulcan	Kaiser Steel Corp.	P.O. Box 217, Fontana	Kelso

Lead

Principal lead producers in California in 1950. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location
Calaveras County:			
Penn	Penn Chemical Company	Campo Seco	Campo Seco
Inyo County:			
Darwin Group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin
Defense	Foreman & Skinner	1354 Second Ave., Salt Lake City, Utah	Panamint Springs
Gold Bottom Tailings	Louis Warnken, Jr.	Darwin	Trona
Keystone	Dale Goyn	Darwin	Darwin
Lead King (Lippincott)	Lippincott Lead Mines	P.O. Box 1811, Santa Ana	Scotty's Castle
Minnietta	Ross Finley & Tom Vignich	Panamint Springs via Lone Pine	Panamint Springs
Ophir Dump	Ned E. Raymond	P.O. Box 12, Westend	Trona
Red Cloud	Harry A. Briggs	P.O. Box 613, Trona	Trona
Reward (Brown Monster)	T. L. & D. Bright and J. F. Nickalous	Independence	Manzanar
Santa Rosa	Santa Rosa Mining Company	Keeler	Keeler
Shoshone group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa
Surprise	A. L. Foss	Panamint Springs via Lone Pine	Panamint Springs
Riverside County:			
Bald Eagle	Dan Figueroa & Sons	Rt. 1, Box 8, Blythe	Cox
Oro Mega	Leslie Spell, Lyman Webster & Arthur Becker	P.O. Box 347, Twentynine Palms	Twentynine Palms
San Bernardino County:			
Carbonate King group	Carbonate King Mines	481 Church St., San Bernardino	Nipton
Kalley	Edward Koppleman	4457 Simpson Ave., North Hollywood	Nipton
Mohawk	Mohawk Mines, Inc.	Nipton	Nipton
Shasta County:			
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Ingot

Metallic Minerals—Continued

Molybdenum

Mine	Operator	Address	Location
Inyo County:			
Pine Creek	U. S. Vanadium Corp.	30 E. 42d St., New York 17, N. Y.	Bishop

Platinum Group Metals

Mine	Operator	Address	Location
Butte County:			
Butte Unit	Yuba Consolidated Gold Fields	351 California St., San Francisco	Oroville
Mariposa County:			
Dredge No. 3	Thurman & Wright	235 Montgomery St., San Francisco	Hornitos
Sacramento County:			
Capital Dredges	Capital Dredging Co.	351 California St., San Francisco	Folsom
Natomas	Natomas Co.	P.O. Box 1197, Sacramento	Folsom
	Schwartz, Mitchell & Wark	Rt. 1, Box 1450, Fair Oaks	Folsom
Shasta County:			
	Thurman Gold Dredging Co.	235 Montgomery St., San Francisco	Redding
Siskiyou County:			
Reeves Ranch	Reeves Ranch Dredging Co.	Happy Camp	Happy Camp
Siskiyou Unit	Yuba Consolidated Gold Fields	351 California St., San Francisco	Callahan
Yuba County:			
Yuba Unit	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton

Metallic Minerals—Continued

Quicksilver (Mercury)

Mine	Operator	Address	Location
Lake County:			
Great Western	Bradley Mining Co.	425 Crocker Bldg., San Francisco	Middletown
Napa County:			
Oat Hill	N. B. Livermore (owner)	216 Pine St., San Francisco	Aetna Springs
San Benito County:			
Aurora	Reyes Diaz	Box 21, Idria	Idria
Juniper	Berg & Sciochetti	Panoche	Panoche
New Idria	New Idria Mining & Chemical Co.	R. 628, 58 Sutter St., San Francisco	Idria
North Star	Leonard W. Knepper	Box 98, Idria	Idria
Santa Clara County:			
Guadalupe	Arthur S. Burrell	Rt. 3, Box 835, Los Gatos	Almaden
New Almaden	Kirk & Stotesbury	Almaden	Almaden
New Almaden Dump	Harry F. Austin	Almaden	Almaden
	Ed Cooper	Santa Clara	
Sonoma County:			
Culver Baer	C. A. Baumeister & Sons	Cloverdale	Cloverdale
Dewey's Geyser	Buckman, Inc.	Geysers Rd., Cloverdale	The Geysers
Mt. Jackson	Sonoma Quicksilver Mines, Inc.	58 Sutter St., San Francisco	Guerneville
Yolo County:			
Reed	Bradley Mining Co.	425 Crocker Bldg., San Francisco	Rumsey

Metallic Minerals—Continued

Silver

Principal silver producers in California in 1950. (Not less than 1,000 ounces.)

Mine	Operator	Address	Location
Amador County:			
Old Eureka (lode gold mine)	Central Eureka Mining Co.	Sutter Creek	Sutter Creek
Butte County:			
Butte Unit (dredge-bucket line)	Yuba Consolidated Gold Fields	351 California St., San Francisco	Oroville
Calaveras County:			
Penn (zinc mine)	Penn Chemical Co.	Camp Seco	Camp Seco
Inyo County:			
Alexander (lead mine)	Moline, Scott & Dunningan	Fish Lake Valley via Tonopah, Nev.	Dyer, Nevada
Darwin group (zinc-lead mine)	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin
Defense (lead mine)	Foreman & Skinner	1354 Second Ave., Salt Lake City, Utah	Panamint Springs
Gold Bottom Tailings (tailings dump)	Louis Warnken, Jr.	Darwin	Trona
Keystone (lead mine)	Dale Goyn	Darwin	Darwin
Lead King (Lippincott) (lead mine)	Lippincott Lead Mines	P.O. Box 1811, Santa Ana	Scotty's Castle
Minnietta (lead mine)	Ross Finley & Tom Vignich	Panamint Springs, via Lone Pine	Panamint Springs
Pine Creek (tungsten mine)	United States Vanadium Corp.	30 E. 42d St., New York, N. Y.	Bishop
Reward (Brown Monster) (lode gold mine, lead mine)	T. L. & D. Bright and J. F. Nickalous	Independence	Manzanar
Santa Rosa (lead mine)	Santa Rosa Mining Co.	Keeler	Keeler
Shoshone group (lead mine)	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa
Surprise (lead mine)	A. L. Foss	Panamint Springs, via Lone Pine	Panamint Springs
Kern County:			
Tropico (lode gold mine)	Burton Mines, Inc., et al.	Rosamond	Rosamond
Whitmore (gold-silver mine)	Lessees of Whitmore Mines, Inc.	Mojave	Mojave
Mariposa County:			
Dredge No. 3 (dragline)	Thurman & Wright	235 Montgomery St., San Francisco	Hornitos

Mono County:			
Silverado (silver mine)	Norman Annette	Sweetwater, via Yerington, Nevada	Sweetwater, Nevada
Nevada County:			
Empire Star group (lode gold mine)	Empire Star Mines, Ltd.	P.O. Box 1027, Grass Valley	Grass Valley
Idaho & Maryland units (lode gold mine)	Idaho Maryland Mines, Corp.	P.O. Box 1028, Grass Valley	Grass Valley
Sacramento County:			
Natomas (dredge-bucket line)	Natomas Co.	P.O. Box 1197, Sacramento	Folsom
San Bernardino County:			
Bagdad Chase—Roosevelt (lode gold mine, copper mine)	Donald F. Love	P.O. Box D, Ludlow	Ludlow
Carbonate King Zinc (zinc mine)	J. Q. Little	Nipton	Nipton
New Trail (copper mine)	Alloy Mining Company	2320 N. Alameda St., Compton	Nipton
Shasta County:			
Afterthought (zinc mine)	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Ingot
Hornet—Richmond (pyrite mine, leaching operation)	Mountain Copper Co., Ltd.	216 Pine St., San Francisco	Matheson
Yankee John Dump (gold-silver mine)	Igo Mining Co.	Redding	Redding
Sierra County:			
Original Sixteen to One (lode gold mine)	Original Sixteen to One Mine, Inc.	1611 Russ Bldg., San Francisco	Alleghany
Yuba County:			
Yuba Unit (dredge-bucket line)	Yuba Consolidated Gold Fields	351 California St., San Francisco	Hammonton

Metallic Minerals—Continued

Tungsten

Mine	Operator	Address	Location
Alpine County:			
Alpine	Alpine Mining Co.	P.O. Box 114, Gardnerville, Nev.	Markleeville
Fresno County:			
Garnet Dike	Garnet Dike Mine	Fresno	Kings River
Inyo County:			
L. & L.	Tungstar Corp.	Box 725, Bishop	Bishop
Pine Creek	United States Vanadium Corp.	30 E. 42d St., New York, N. Y.	Bishop
Yaney	R. W. Adams & B. W. Van Voorhis, Jr.	Bishop	Bishop
Kern County:			
Big Boy	Frank Feldman	Rt. 3, Box 783, Porterville	Randsburg
Blue Bird	L. J. Sain	Box 342, Randsburg	Randsburg
F. O. B. No. 2	Hatton & Lamley	1104 W. 99th St., Los Angeles	Agua Caliente
Madera County:			
San Joaquin	San Joaquin Tungsten Mine	Northfork	Northfork
Strawberry	Fresno Mining Co.	415 Brix Bldg., Fresno	Bass Lake
Mono County:			
Black Rock	Tungstar Corp.	Box 725, Bishop	Benton
San Bernardino County:			
Mary Ann	Adelanto Mining Co., Inc.	Box 275, Adelanto	Adelanto
Section 9	Walter H. Zindell	Box 71, Essex	Essex
Spud Patch	Surcease Mining Co.	P.O. Box 786, Sacramento	Atolia
Starbright	Mineral Materials Co.	1145 Westminster Ave., Alhambra	Barstow
Treasure No. 2	G. E. Benware	Bishop	Atolia
Tulare County:			
Big Jim	Tulare County Tungsten Mines	Box 361, Lindsay	Lindsay
Harrell Hill	Consolidated Tungsten	Box 366, Dinuba	Orosi
Herbert	Herbert Mines	Rt. 5, Box 150A, Porterville	Porterville
Sherman Peak	Sherman Peak Mining Co.	Kernville	Kernville

Metallic Minerals—Continued

Titanium Ore

Mine	Operator	Address	Location
Los Angeles County:			
	Ferro-Titan Minerals Co.	212 Bank of America Bldg., Glendale	Saugus
	Thomas J. Wright & Walter Johnstone	100 E. Colorado Blvd., Pasadena	Hermosa Beach

Zinc

Principal zinc producers in California in 1950. (Not less than 10,000 pounds.)

Mine	Operator	Address	Location
Calaveras County:			
Penn	Penn Chemical Company	Campo Seco	Campo Seco
Inyo County:			
Darwin group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Darwin
Red Cloud	Harry A. Briggs	P.O. Box 613, Trona	Trona
Shoshone group	Anaconda Copper Mining Co.	25 Broadway, New York, N. Y.	Tecopa
San Bernardino County:			
Carbonate King Zinc	J. Q. Little	Nipton	Nipton
Shasta County:			
Afterthought	Coronado Copper & Zinc Co.	1206 Pacific Mutual Bldg., Los Angeles	Ingot

List of Smelters and Mineral Dealers Reporting Purchase of California Metals Produced in 1950

Name	Address	Location of plant	Metals reported purchased
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Amarillo, Tex.	Zinc
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	El Paso, Tex.	Copper, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Garfield, Utah	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Hayden, Ariz.	Copper, gold, silver
American Smelting & Ref. Co.	405 Montgomery St., San Francisco	Selby	Copper, lead, gold, silver
American Smelting & Ref. Co.	120 Broadway, New York, N. Y.	Tacoma, Wash.	Copper, lead, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N. Y.	Anaconda, Mont.	Copper, lead, zinc, gold, silver
Anaconda Copper Mining Co.	25 Broadway, New York 4, N. Y.	Great Falls, Mont.	Zinc
Bethlehem Pacific Coast Steel Corporation	20th and Illinois Sts., San Francisco	San Francisco	Iron ore
Bradley & Ekstrom	320 Market St., San Francisco	San Francisco	Manganese, chromite, iron ore
Bradley Mining Co.	Crocker Bldg., San Francisco	Stibnite, Idaho	Antimony
Braun Corporation	2260 E. 15th St., Los Angeles	Los Angeles	Quicksilver
Coast Chemical Division F. W. Berk & Co., Inc.	Sharon Bldg., San Francisco	San Francisco	Quicksilver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Miami, Ariz.	Copper, gold, silver
International Smelting & Ref. Co.	Kearns Bldg., Salt Lake City, Utah	Tooele, Utah	Copper, lead, zinc, gold, silver
Kaiser Co., Inc.	P.O. Box 217, Fontana	Fontana	Iron ore, manganese ore, chromite
Kennecott Copper Corp.	120 Broadway, New York, N. Y.	McGill, Nev.	Copper, gold, silver
Mefford Chemical Co.	1026 Sante Fe, Los Angeles	Los Angeles	Quicksilver
Pacific Vegetable Oil Co., Bernard T. Rocca	62 Townsend St., San Francisco	San Francisco	Quicksilver
Phelps-Dodge Corp.	40 Wall St., New York, N. Y.	Ajo, Ariz.	Copper, gold, silver
Quicksilver Producers Ass'n., Irving Ballard, Sec'y.	407 Sansome St., San Francisco	San Francisco	Quicksilver
Sullivan Mining Co.	Wallace, Idaho	Silver King, Idaho	Zinc
Twining Laboratories	2527 Fresno St., Fresno	Fresno	Tungsten ore
U. S. Mint	Duboce & Market Sts., San Francisco	San Francisco	Gold, silver
U. S. Smelting, Refining & Mining Co.	Newhouse Bldg., Salt Lake City, Utah	Midvale, Utah	Copper, lead, zinc, gold, silver
United States Vanadium Corp.	30 E. 42d St., New York, N. Y.	Bishop	Tungsten ore
Western Gold & Platinum Works	589 Bryant St., San Francisco	San Francisco	Platinum, gold, silver*
Wildberg Bros. Smelting & Ref. Co.	742 Market St., San Francisco	San Francisco	Platinum, gold, silver*

* Gold and silver in special high-grade ores only.

DIRECTORY OF MINERAL DEALERS AND COMMERCIAL LABORATORIES

List of Mineral Dealers, Custom Mills, and Commercial Grinding Plants in California

Firm	Remarks
American Minerals Co., 840 Mission Rd., Los Angeles.	Commercial grinding of minerals.
Atkins, Kroll & Co., 320 California St., San Francisco 4.	Dealer in tungsten ores, mercury, gypsum and limerock.
Baroid Sales Division National Lead Co., 830 Ducommun St., Los Angeles.	Talc and other soft non-metallic minerals ground by contract or purchased.
Bishop Concentrate & Cleaning Co., Bishop.	Custom mill; purchases tungsten ores and base metal ores.
Blood, Harry E., Co., 5028 Alhambra Ave., Los Angeles	Dealer in industrial sand and silica products.
Bradley & Ekstrom, 320 Market St., San Francisco 11	Dealer in all commercial minerals.
Brumley-Donaldson Co., 557 Howard St., San Francisco 5, and 3050 E. Slauson Ave., Huntington Park	Dealer in sand, clay, limestone, dolomite, and other minerals.
Burton Bros., Rosamond, Kern County	Custom cyanide mill. Gold and silver ores purchased.
Butte Lode Mining Co., Randsburg	Custom amalgamation mill, gold-silver ore.
Castle Crags Chrome Co., Box 126X, Castella	Dealer in or custom milling of chrome ores.
Commercial Minerals Co., 310 Irwin St., San Francisco 7	Commercial grinding by contract or minerals purchased.
Dailey Chemical Laboratories, Box 228, Oroville	Custom mill for black sands.
Empire Star Mines Co., Ltd., Grass Valley	Amalgamation, flotation and cyanide mill; gold ore and concentrates purchased.
Hidecker Co., 800 S. Mission Rd., Los Angeles	Clay grinding plant; non-metallic minerals ground by contract or purchased.
Hill Bros. Chemical Co., 2159 Bay St., Los Angeles	Grinding asbestos, and custom milling of small lots of soft non-metallic minerals.
Huntley Industrial Minerals, P.O. Box 305, Bishop	Dealer in talc, pyrophyllite, garnet sands, clay and mica.
Industrial Minerals & Chemical Co., 836 Gilman St., Berkeley	Non-metallic minerals ground by contract or purchased.
Kennedy Minerals Co., 2552 E. Olympic Blvd., Los Angeles	Non-metallic minerals ground by contract or purchased.
Los Angeles Chemical Co., 1960 S. Santa Fe Ave., Los Angeles	Dealer in non-metallic minerals.
Mojave Mining & Milling Co., Martin Beck, Mojave	Custom mill, amalgamation and flotation.
Ontario Rock Milling Co., 7557 E. Olive, Paramount	Non-metallic minerals ground by contract or purchased. Roofiing granules prepared.
Sierra Talc & Clay Co., 5509 Randolph St., Los Los Angeles 22	Dealer in talc and clays.
Southern California Minerals Co., 320 S. Mission Rd., Los Angeles	Dealer in talc, clay and other minerals.

List of Mineral Dealers, Custom Mills, and Commercial Grinding Plants in California—Continued

Firm	Remarks
Twining Laboratories, 2527 Fresno St., Fresno	Purchase and concentrate tungsten ores on a custom basis, also commercial grinding.
U. S. Vanadium Co., Bishop	Tungsten mill, ore purchased.
Western Talc Co., 1901 E. Slauson Ave., Los Angeles	Non-metallic mineral grinding plant; minerals ground by contract or purchased.
Yuba Milling Co., 1069 Second St., Berkeley 10	Non-metallic mineral grinding by contract or purchase.

List of Commercial Assay and Testing Laboratories

San Francisco Area

Firm	Services
American Spectrographic Laboratories, 557 Minna St., San Francisco	Spectrographic analysis of minerals and water by quantitative methods. Radioactivity measurements.
Ball, C. M., 911 University Ave., Berkeley 2	Fire assay, chemical analysis of ores and minerals.
Curtis & Thompkins, Ltd., 236 Front St., San Francisco 11	Chemical analysis and specification testing of metallic ores, metals, and non-metallic minerals.
Hall Laboratories, Inc., 200 Davis St., San Francisco 11	Consulting water chemists.
Hanks, Abbot A., Inc., 624 Sacramento St., San Francisco 11	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests, spectrographic analysis, water analysis.
Hersey Inspection Bureau, 3405 Piedmont Ave., Oakland	Engineers, chemists, and testers of building materials, foundations.
Hunt, Robert W., Co., 251 Kearny St., San Francisco 8	Fire assay, analysis of ceramic materials, analysis of ores and minerals, spectrographic analysis, water analysis.
Krebs, Kellogg, 564 Market St., San Francisco 4	Ore dressing, mineral beneficiation.
Metallurgical Laboratories, 604 Mission St., San Francisco 5	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, spectrographic analysis, water analysis.
Multiphase, Inc., 351 Eighth St., San Francisco 3	Spectrographic analysis.
Pacific Chemical Laboratories, 617 Montgomery St., San Francisco 11	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis, spectrographic analysis, water analysis.
Pittsburg Testing Laboratories, 651 Howard St., San Francisco 5	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis, water analysis.
Western Gold and Platinum Works, 589 Bryant St., San Francisco 7	Fire assay, chemical analysis of ores and minerals, ore dressing beneficiation.
Western Machinery Co., 760 Folsom St., San Francisco 7	Ore dressing, mineral beneficiation, coal washing, sand preparation.
Wildberg Bros. Smelting & Refining Co., 742 Market St., San Francisco 2	Fire assay and chemical analysis.

Los Angeles Area

Firm	Services
California Testing Laboratories, Inc., 619 E. Washington, Los Angeles 15	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical tests.
Dorr Co., 811 W. Seventh St., Los Angeles 14	Ore dressing, mineral beneficiation.
Eisenhauer, Ed., Jr., 322 S. San Pedro St., Los Angeles	Fire assay, chemical analysis of ores and minerals.
Herr, A. V., 5176 Hollywood Blvd., Los Angeles	Fire assay, chemical analysis of ores and minerals.
Hollywood Testing Laboratories, 1257 N. La Brea Ave., Hollywood 38	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing beneficiation, petrographic analysis, physical tests, spectrographic analysis, water analysis, X-ray diffraction.
Hunt, Robert W., Co., 6353 Miles Ave., Huntington Park	Chemical analysis of ores and minerals.
Keldon Research Corporation, Box 2555, Terminal Annex, Los Angeles 54	Chemical analysis of ores and minerals; chemical analysis of ceramics; spectrographic analysis, water analysis.
Kennard & Drake, 3364 E. 14th St., Los Angeles 23	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis.
Los Angeles Testing Laboratory, 1300 S. Los Angeles St., Los Angeles 15	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic analysis.
Meco Assayers, 417 S. Hill St., Los Angeles 13	Fire assay, chemical analysis of ores and minerals.
Metal Control Laboratories, 2735 E. Slauson Ave., Huntington Park	Chemical analysis of ores, minerals and metals, physical tests, spectrographic analysis and metallurgical examinations.
Minerals Engineering, 417 S. Hill St., Los Angeles 13	Ore dressing, beneficiation of ores and minerals.
The National Supply Co., 1524 Border Ave., Torrance	Chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests.

List of Commercial Assay and Testing Laboratories—Continued

Los Angeles Area—Continued

Firm	Services
Osborne, Raymond G. Laboratories, 110 W. Ninth St., Los Angeles 15	Chemical analysis of ceramic materials, chemical analysis of ores and minerals, physical testing of construction materials.
Sill, Harley A., 1011 S. Figueroa St., Los Angeles 15	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, petrographic analysis.
Smith-Emery Co., 920 Santee St., Los Angeles 15	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, petrographic analysis, spectrographic analysis.
Southwestern Engineering Co., 4800 S. Santa Fe Ave., Los Angeles	Ore dressing, beneficiation of minerals.
Triplett & Barton, Inc., 831 N. Lake St., Burbank	Chemical analysis of ores and minerals, spectrographic analysis (rare earth analyses), X-ray diffraction metallography.
Truesdail Laboratories, Inc., 4101 N. Figueroa, Los Angeles 65	Chemical analysis of ores and minerals physical testing of ferrous and non-ferrous metals and alloys.
von Huene, Rudolph, 865 N. Mentor Ave., Pasadena 6	Thin and polished sections.
Ward, S. Paul, Inc., 605 Mission St., South Pasadena	Ceramic testing.

Other Areas

Bishop Assay Office, 381 N. Main St., Bishop	Fire assay; chemical analysis of ores, minerals, and tungsten ores; testing laboratory.
Calaveras Assay Office, P.O. Box 645, Angels Camp	Fire assay, chemical analysis of ores and minerals, milling tests.
Clarkson Chemical Laboratories, 1550 Sixth Ave., San Diego	Fire assay, chemical and spectrographic analysis of ores and minerals.
Dailey Chemical Laboratory, Box 228, Oroville	Black sand assay.
Martin C. Engel, Cantil	Fire assay; chemical analysis of ores and minerals.
Grant, Ernest V., 26 Broadway, Jackson	Fire assay, chemical analysis of ores and minerals, mill test.
Hornkohl Laboratories, 716 Truxton Ave., Bakersfield	Fire assay, chemical analysis of ores and minerals, analysis of oil cores, oils, muds, water, industrial hazards.
Morse Laboratories, 316 16th St., Sacramento	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, beneficiation, physical tests, spectrographic, analysis, chemical and mining engineers.
Mountain States Uranium Corp., P.O. Box 929, Bishop	Fire assay; chemical analysis of ores and minerals, analysis of raw ceramic materials; analysis of tungsten ores; water analysis.
Nevada City Assay & Refining Office, E. J. N. Ott, 130 Main St., Nevada City	Fire assay, chemical analysis of ores and minerals, mill tests.
Peninsula Laboratories, 544 S. San Antonio Rd., P.O. Box 372, Los Altos	Chemical analysis of ores and minerals, ore dressing and beneficiation, analysis of petroleum and oil analysis.
Rombough, M. D., 3069 Del Paso Blvd., North Sacramento	Fire assay, chemical analysis of ores and minerals, mill tests.
San Joaquin Research Laboratory, 2253 S. McKinley Ave., Box 1987, Stockton	Fire assay, chemical analysis of ores and minerals.
Scheave, Harold, 237 Commercial St., Nevada City	Fire assay, chemical analysis of ores and minerals.
Twining Laboratories, 2527 Fresno St., Box 1472, Fresno	Fire assay, chemical analysis of ceramic materials, chemical analysis of ores and minerals, ore dressing, petrographic analysis, physical tests, spectrographic analysis, water analysis, X-ray diffraction.

The Division of Mines laboratory provides free identification of rocks and minerals, based on physical, chemical, and optical examination for residents of California. Quantitative analyses, both chemical and spectrographic, and assays for the metals can be obtained from commercial chemists and assayers specializing in this work. For gold and silver determinations, please patronize commercial assayers.

STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

FABRICAS

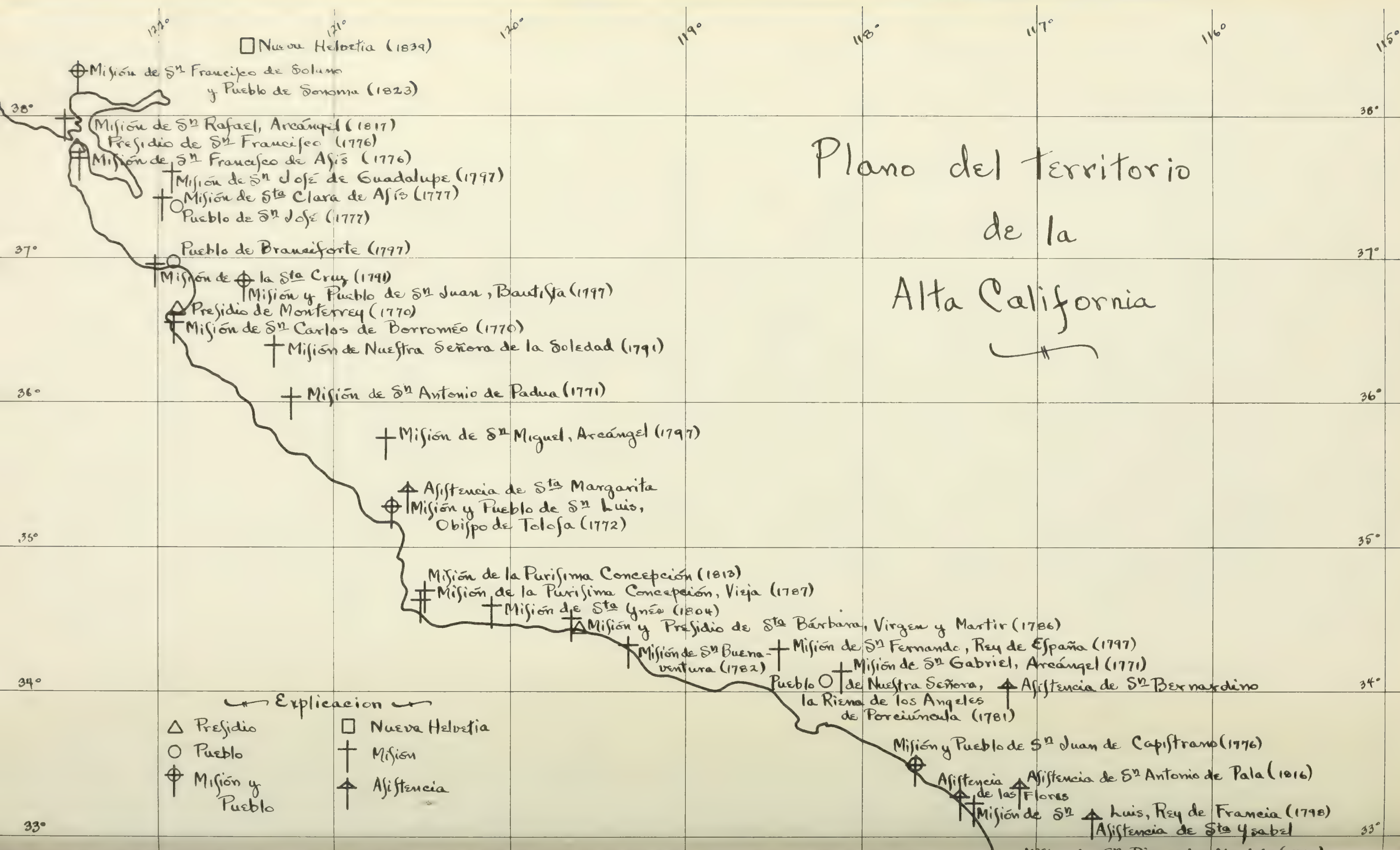
* * * * *

A Collection of Pictures and Statements on the Mineral Materials Used in Building in California Prior to 1850

* * * * *

Assembled by
ELISABETH L. EGENHOFF

As a Supplement to the
California Journal of Mines and Geology for April 1952



Plano del territorio de la Alta California
Nueva Helvetia (1839)
Misión de Sn Francisco de Solano y Pueblo de Sonoma (1823)
Misión de Sn Rafael, Arcángel (1817)
Presidio de Sn Francisco (1776)
Misión de Sn Francisco de Asís (1776)
Misión de Sn José de Guadalupe (1797)
Misión de Sta Clara de Asís (1777)
Pueblo de Sn José (1777)
Pueblo de Branciforte (1797)
Misión de la Sta Cruz (1791)
Misión y Pueblo de Sn Juan, Bautista (1797)
Presidio de Monterrey (1770)
Misión de Sn Carlos de Borroméo (1770)
Misión de Nuestra Señora de la Soledad (1791)
Misión de Sn Antonio de Padua (1771)
Misión de Sn Miguel, Arcángel (1797)
Asistencia de Sta Margarita
Misión y Pueblo de Sn Luis, Obispo de Tolosa (1772)
Misión de la Purisima Concepción (1813)
Misión de la Purisima Concepción, Vieja (1787)
Misión de Sta Ynés (1804)
Misión y Presidio de Sta Bárbara, Virgen y Martir (1786)
Misión de Sn Buenaventura (1782)
Misión de Sn Fernando, Rey de España (1797)
Misión de Sn Gabriel, Arcángel (1771)
Pueblo de Nuestra Señora, la Riena de los Angeles de Porciúncula (1781)
Asistencia de Sn Bernardino
Misión y Pueblo de Sn Juan de Capistrano (1776)
Asistencia de las Flores
Asistencia de Sn Antonio de Pala (1816)
Misión de Sn Luis, Rey de Francia (1798)
Asistencia de Sta Ysabel
Explicacion
Presidio
Pueblo
Misión y Pueblo
Nueva Helvetia
Misíon
Asistencia
122°
121°
120°
119°
118°
117°
116°
115°
38°
37°
36°
35°
34°
33°

FOREWORD

Fabricas, a chronicle of the use of mineral materials in building in California prior to 1850, is the second in the Division of Mines series of documents on the history of discovery and development of mineral materials in California. The first, *The Elephant As They Saw It,* covers the history of gold mining to 1862, and was issued as a centennial supplement to the *California Journal of Mines and Geology* for October 1949.

Since the release of *The Elephant,* numerous requests for a similar publication on California missions have been received. *Fabricas* is presented partly in response to these requests, for the history of the early use of building materials in California is in large part the history of building at the California missions; but it has been prepared chiefly as a chronicle of California's first documented mineral industry—the procuring of nonmetallic mineral materials for use in construction—which ranks second only to the petroleum industry in value of production today.

As in *The Elephant,* the data in *Fabricas* are presented through the words and drawings of contemporary writers and artists. Some of the extracts (which have been reproduced literally from the original records whenever it has been possible to do so) are in Spanish, French, or German, because English was the native language of a minority group only in the State prior to the Gold Rush of 1849. For all extracts in foreign languages, however, English translations are appended.

For their help in collecting and preparing for publication the material contained in this compilation, I wish to thank Mrs. Geil Bartels Braun, formerly of the Division of Mines Editorial Section staff; Misses Mary Rae Hill and Madeline Hernandez, presently of the Editorial Section staff; and Miss Geraldine E. Martino. I should like also to express appreciation to Mrs. Edith Webb of Los Angeles, Mrs. Dorothy Shadi of Berkeley, and Father Maynard Geiger of Mission Santa Barbara, who have responded generously to numerous requests for assistance; to the California State Library in Sacramento, the Bancroft Library and General Library of the University of California at Berkeley, The Huntington Library in San Marino, the Santa Barbara Archives at the Old Mission in Santa Barbara, The Society of California Pioneers in San Francisco, the California Historical Society in San Francisco, the Serra Museum of the San Diego Historical Society in San Diego, the Southwest Museum in Highland Park in Los Angeles, the Los Angeles County Museum in Exposition Park in Los Angeles, the M. H. de Young Memorial Museum in Golden Gate Park in San Francisco, The Book Club of California in San Francisco, and the Museo Naval in Madrid, for making material from their collections of Californiana available to us; and to the staff members of each of the above institutions, who have given us so much patient assistance during the two years we have been collecting the data presented herein.

ELISABETH L. EGENHOFF
Editor, Division of Mines
January 15, 1952.

CONTENTS

"FABRICA (fah'-bre-cah), f. 1. Fabrication, the act and manner of building. 2. Fabric, frame. 3. Fabric, structure, building, edifice. 4. Manufactory. 5. Manufacture. 6. A fantastic or chimerical idea." Velazquez.

IN CONSPECT
1786-1850

THE FRANCISCAN FATHERS

On Construction at Santa Barbara Mission

1786-1820 *

[English translation is on pages 153 to 167.]

†

VIVA JESUS

Informe de la Mision de la Virgen, y Martir Sta Barbara, sita en el canal de dicha Sta; asi de lo espiritual, como de lo temporal: y comprehende desde el dia 4. de Diciembre del año 1786; que fue el de la fundacion, hasta el dia 31. de Diciembre de 1787.

Año 1787. Dia 4. de Diciembre del año 1786; en q. celebra N.S.M. Iglesia la Fiesta de la V. y M. Sta Barbara, se puso la SSmã Cruz en el sitio donde se fundo la Mision dedicada ã la dicha Sta Virgen y Martir, llamado el Pedragoso, distante como un quarto de legua del Rt Presidio de la expresada Sta, y el dia 15. del reterido mes, y año en una enramada, q. se hizo, celebro la primera Misa, y predico el R.P. Preste Fr Fermin Francõ de Lasuen con asistencia del Sr Governr, y algunos soldados, q. le acompañaban: Y por ser el tiempo riguroso del invierno, en q. son las agua, en este paiz, y haver sido abundantes, y continuas las lluvias, no se pudo fabricar edificio alguno, aunq. se cortaron algunas maderas, para gdõ el tiempo diese lugar pa las Fabricas. Los Ministros primeros, q. puedaron señalados por el R. P. Preste para esta fundacion, fueron los PP. PPres Fr Antonio Paterna, y Fr Christoval Oramas, los q. se han mantenido, y mantienen en esta sobre dicha Mision, y dan esta Informe, q. es del tenor siguiente. . . . .

Fabricas. Se ha fabricado una casa de 16. vs de largo, y 5. de ancho, dividida en dos piezas pa habitn de los Padres, cercada de varas, y embarrada con el techo de sacate. Contiguo ã esta, un quarto de 6. vs de largo, y 5. de ancho con el techo de terrado, y sobre este otro de sacate, y sirve de cocina. Item: una trox de 21. vs de largo, y 5. de ancho, cercada de palos, y embarrada con el techo de sacate. Item: una casa de 12. vs de largo, y 5. de ancho, cercada de varas, y embarrada, con el techo de sacate, y esta sirve pa recoger las Mugeres solteras, y Muchachas. Item: una Capilla de 14. vs de largo, y 5. de ancho, cercada de varas, y embarrada, con el techo de sacate. Item: un quarto de 6. vs de largo, y 5. de ancho, cercado, y techado de terrado, y este sirve pa los sirvientes. Item: un quarto de 10. vs de largo, y 5. de ancho, cercado de varas, y embarrado, con el techo de terrado, y este sirve pa carpinteria, y recogerse los solteros, y muchachos. Item: 4. piezas, o quartos, uno de 8. vs de largo, 2. de 6. vs, y el otro de 5.: todos de 6. vs de ancho, y de pared de adove de una vara de ancho. No se han podido cubrir por estas las aguas immediatas. . . . .

Fr Antonio Paterna — Fr Christoval Oramas

---

* The Santa Barbara Mission Archives at the Old Mission, Santa Barbara, California, are the depository for most of the rare manuscript records kept by the Franciscan Fathers during their pre-secularization administration of the California missions. Manuscript copies of these valuable historical documents, made toward the end of the nineteenth century, are also preserved in the collection of the Bancroft Library at the University of California in Berkeley.

Several sets of records were kept at the missions. *Annual* and *Biennial Reports*, listing property and summarizing accomplishments, were made regularly by the Padres Ministros to the Padre Presidente. A *Libro de Patentes*, also kept at each mission, contained copies of official letters. At Santa Barbara, the annual and biennial reports were also copied into the *Libro de Patentes*, and so were fortunately preserved.

The excerpts on *Fabricas* have been drawn from the original annual reports, if available, otherwise from copies of the reports in the *Libro de Patentes*. Excerpts are printed herein by permission of Old Mission, Santa Barbara, California, through the kindness of Fr. Maynard Geiger, Archivist.

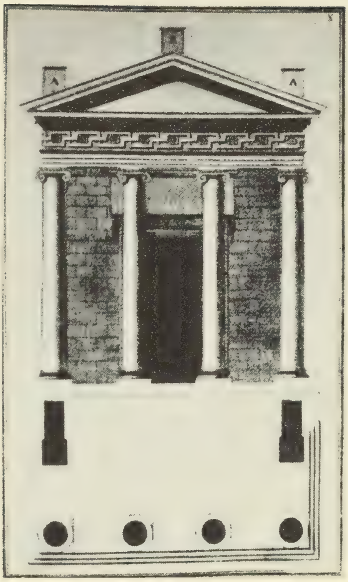


FIGURE 1. Plate X from the 1787 Spanish edition of Vetruvius' *De Architectura Libri Decem [Los diez libros de Architectura . . . traducidos . . . y commentados por Don J. Ortiz Sanz, Madrid, 1787].*

The architect Marcus Vitruvius Pollio practised in Rome, and in the service of the emperors, shortly before the beginning of the Christian era. His work *De Architectura Libri Decem* (Ten Books on Architecture), written about 25 B.C., has been translated into five or more languages. Not counting the rare manuscript copies, a few of which still exist, at least 42 editions are known to have been released prior to 1820: seventeen in Latin, issued between 1486 and 1807; two in Spanish, issued in 1602 and 1787; six in French, issued between 1547 and 1816; four in German, issued between 1548 and 1796; two in English, issued in 1771 and 1791; and eleven in Italian, issued between 1521 and 1790. One of the Spanish editions (1787) is still in the Archives at Mission Santa Barbara.

The following Latin excerpts, which illustrate the type of information available to the missionaries at Santa Barbara and the other Franciscan establishments in California, are from *Vitruvius on Architecture, Edited from the Harleian Manuscript 2767. . . . . by Frank Granger, D.Lit., A.R.I.B.A. Professor in University College, Nottingham, in two volumes; London: William Heinemann Ltd. New York, G. P. Putnam's Sons, MCMXXXI.* Harleian 2767, which probably dates from the 8th century A.D., is the oldest known manuscript of Vetruvius' *Libri Decem.* It is now in the British Museum.

The English translation that follows the Latin excerpts is from *The Architecture of Marcus Vitruvius Pollio in Ten Books, Translated from the Latin by Joseph Gwilt, F.S.A., F.R.A.S., Author of an Encyclopaedia of Architecture and Other Works; A New Edition, Carefully Revised by the Translator, and with Additional Plates; London, Lockwood & Co., 7, Stationers' Hall Court, Ludgate Hill 1874.*

[II-III] "Itaque primum de lateribus, qua de terra duci eos oporteat, dicam. Non enim de harenoso, neque calculoso, luto neque sabulonoso sunt ducendi, quod, ex his generibus cum sint ducti, primum fiunt graves, deinde, cum ab inbribus in parietibus sparguntur, dilabuntur, et dissolvuntur, paleaeque in his non cohaerescunt propter asperitatem. Faciendi autem sunt ex terra albida cretosa sive de rubrica aut etiam masculo sabulone; haec enim genera propter levitatem habent firmitatem et non sunt in opere ponderosa et faciliter aggerantur. Ducendi autem sunt per vernum tempus et autumnale, ut uno tempore siccescant. Qui enim per solstitium parantur, ideo vitiosi fiunt, quod, summum corium sol acriter cum praecoquit, efficit ut videatur aridum, interior autem sit non siccus; et cum postea siccescendo se contrahit, perrumpit ea quae erant arida. Ita rimosi facti efficiuntur imbecilli. Maxime autem utiliores erunt, si ante biennium fuerint ducti; namque non ante possunt penitus siccescere. Itaque cum recentes et non aridi sunt structi,

Informe de la Mission de la V. y M. Sta Barbara sita en el Canal de la dicha Sta; asi de lo espiritual, como temporal, y comprehende desde 1. de enero de 1788. hasta el dia ultimo de Junio del expresado año.

Año 1788. . . . . Fabricas. No se ha fabricado cosa alguna mas que un corral de Palos parados para el ganado; y la causa ha sido la falta de viveres pa mantener ã los Indios en la Mision. . . . .

Fr Antonio Paterna Fr Christoval Oramas

Informe de la Mision de la V. y M. Sta Barbara, sita en el canal de la dicha Sta; asi de lo espiritual, como de lo temporal, y comprehende desde el 1o de Julio de 1788; hasta el dia 31. de Diciembre del expresado año.

Año 1788. . . . . Fabricas. Se ha techado, y cubierto de teja los 4. quartos, o piezas de q. se hizo mension en el primer informe, y se les han hecho sus puertas. Item: se ha cubierto de teja la casa q. servia, y sirve pa las Mugeres solteras, y Muchachas. Asi mismo se ha puesto teja ã la casa q. servia ã los solteros, y al presente sirve de trox. Item: se ha fabricado una casa, como de 12. varas de largo, y 5. ancho cercada de palos, y cubierta de teja. Item: un quarto de adoves, cubierto de teja, y este sirve de cocina. Se le ha alargado ã la Iglesia un pedazo, y este es de medio adove, techado con teja. . . . .

P. Fr Antonio Paterna Fr Christoval Oramas

---

tectorio inducto rigidoque obsolidati permanent; ipsi sidentes non possunt eandem altitudinem qua est tectorium, tenere, contractioneque moti non haerent cum eo, sed a coniunctione eius disparantur; igitur tectoria ab structura seiuncta propter tenuitatem per se stare non possunt, sed franguntur, ipsique parietes fortuito sidentes vitiantur. Ideo etiam Uticenses laterem, si sit aridus et ante quinquennium ductus, cum arbitrio magistratus fuerit ita probatus, tunc utuntur in parietum structuris. . . . .

[II-IV] "In caementiciis autem structuris primum est de harena quaerendum, ut ea sit idonea ad materiem miscendam neque habeat terram commixtam. Genera autem harenae fossiciae sunt haec: nigra, cana, rubra, carbunculum. Ex his, quae in manu confricata, vel icta fecerit stridorem, erit optima; quae autem terrosa fuerit, non habebit asperitatem. Item si in vestimentum candidum ea contecta fuerit, postea excussa aut icta id non inquinarit neque ibi terra subsiderit, erit idonea. Sin autem non erunt harenaria, unde fodiatur, tum de fluminibus aut e glarea erit excernenda, non minus etiam de litore marino. Sed ea in structuris haec habet vitia: difficuler siccescit, neque onerari se continenter recipit; paries patitur, nisi intermissionibus requiescat, neque concamerationes recipit. Marina autem hoc amplius, quod etiam parietes, cum in is tectoria facta fuerint, remittentes salsuginem eorum dissolvuntur. Fossiciae vero celeriter in structuris siccescunt, et tectoria permanent, et concamerationes patiuntur, sed hae, quae sunt de harenariis recentes. Si enim exemptae diutius iacent, ab sole et luna et pruina concoctae resolvuntur et fiunt terrosae. Ita cum in structuram coiciuntur, non possunt continere caementa, sed ea ruunt et labuntur oneraque parietes non possunt sustinere. Recentes autem fossiciae cum in structuris tantas habeant virtutes, eae in tectoriis ideo non sunt utiles, quod pinguitudini eius calx palea commixta, propter vehementiam non potest sine rimis inarescere. Fluviatica vero propter macritatem uti signinum liaculorum subactionibus in tectorio recipit soliditatem.

[II-V] "De harenae copiis cum habeatur explicatum, tum etiam de calce diligentia est adhibenda, uti de albo saxo aut silice coquatur; et quae erit ex spisso et duriore, erit utilis in structura, quae autem ex fistuloso, in tectoriis. Cum ea erit extincta, tunc materia ita misceatur, ut, si erit fossicia, tres harenae et una calcis infundatur; si autem fluviatica aut marina, duo harenae una calcis coiciatur. Ita enim erit iusta ratio mixtionis temperaturae. Etiam in fluviatica aut marina se qui testam tunsam et succretam ex tertia parte adiecerit, efficiet materiae temperaturam ad usum meliorem. . . . .

[II-VII] "De calce et harena, quibus varietatibus sint et quas habeant virtutes, dixi. Sequitur ordo de lapidicinis explicare, de quibus et quadrata saxa et caementorum ad aedificia eximuntur copiae et conparantur. Haec autem inveniuntur esse disparibus et dissimilibus virtutibus. Sunt enim aliae molles . . . . . aliae temperatae . . . . . nonnullae durae. . . . . Sed haec omnia quae mollia sunt, hanc habent utilitatem, quod ex his saxa cum sunt exempta, in opere faciliter tractantur. Et si sunt in locis tectis, sustineant laborem, si autem in apertis et patentibus, gelicidiis et pruina congesta friantur et dissolvuntur. Item secundum oram maritimam ab salsugine exesa diffluunt neque perferunt aestus. . . . .

Informe de la Mision de la V. y M. Sta Barbara, sita en el canal de la dicha Sta; asi de lo espiritual, como de lo temporal. Comprehende desde el dia 1. de Enero del año 1789. hasta el dia 31. de Diciembre del expresado año.

Año 1789. . . . . Fabricas. Primerame se ha fabricado una Iglesia de 30. varas de largo, y 6. de ancho, de adoves, y cubierta de teja con su puerta. Item: una troj de 31. varas de largo, y 7. de ancho, de adoves, y cubierta de teja. Item: contigua ã esta dicha un quarto de 12. vs de largo, y 7. de ancho, de adoves, y cubierto de teja. Este sirve para las Mugeres solteras, y Muchachas. Item: 2. quartos de ã 5. vs de largo, y 4 y media de ancho, de adoves, y techado con teja, y sirven, el uno de gallinero, y el otro de carcel. Item: un quarto de 9. vs de largo, y 5. de ancho cercado de palos, y cubierto de teja. Este sirve pa los aparejos, y cosas pertenecientes ã la arrieria. . . . .

Y paraje conste &c. Fr Antonio Paterna

Informe de la Mision de la V. y M. Sta Barbara sita en el canal del la dicha Sta asi de lo espirl, como de lo temporal. Comprehende desde el dia 1. de enero del año 1790. hasta el dia 31. de Diciembre del expresado año.

Año 1790. . . . . Fabricas. Primerame: se han fabricado dos viviendas pa los PP. Ministros de 10. vs de largo, y 6. de ancho, repartidas en una sala de 6. vs, y una alcoba de quarto. Todas estas 4. piezas con sus puertas, y ventanas correspondientes, y cubiertas de teja. Item: un lienzo de 60. vs de largo, y 6. de ancho, repartido en 8. piezas, q. son Refectorio, Cocina, Lugar comun, casa e aparejos, Puerta, Casa de leña, Carcel, Molenderia, y casa pa Mugeres. Todo cubierto de teja, y con sus puertas, y ventanas correspondientes. Item: una pieza de 12. vs de largo, y 7. de ancho pa troj, cubierta de teja. Item: una pozolera cubierta de teja. Todas estas piezas son de adove, y enjarradas con mescla. . . . .

Y paraje conste lo firmamos en esta Mision de Sta Barbara hoy dia 31. de Diciembre de 1790.

Fr Antonio Paterna Fr Jose de Miguel

"*Book the Second—Chapter III.—Of Bricks.* I shall first treat of bricks, and the earth of which they ought to be made. Gravelly, pebbly, and sandy clay are unfit for that purpose; for if made of either of those sorts of earth, they are not only too ponderous, but walls built of them, when exposed to the rain, moulder away, and are soon decomposed, and the straw, also, with which they are mixed will not sufficiently bind the earth together, because of its rough quality. They should be made of earth of a red or white chalky, or a strong sandy nature. These sorts of earth are ductile and cohesive, and not being heavy, bricks made of them are more easily handled in carrying up the work. The proper seasons for brick-making are the spring and autumn, because they then dry more equably. Those made in the summer solstice are defective, because the heat of the sun soon imparts to their external surfaces an appearance of sufficient dryness, whilst the internal parts of them are in a very different state; hence, when thoroughly dry, they shrink and break at those parts which were dry in the first instance; and thus broken, their strength is gone. Those are best that have been made at least two years; for in a period less than that they will not dry thoroughly. When plastering is laid and sets hard on bricks which are not perfectly dry, the bricks, which will naturally shrink, and consequently occupy a less space than the plastering, will thus leave the latter to stand of itself. From its being extremely thin, and not capable of supporting itself, it soon breaks to pieces; and in its failure sometimes involves even that of the wall. It is not, therefore, without reason that the inhabitants of Utica allow no bricks to be used in their buildings which are not at least five years old, and also approved by a magistrate.

"*Chapter IV.—Of Sand.* In buildings of rubble work it is of the first importance that the sand be fit for mixing with the lime, and unalloyed with earth. The different sorts are these; black, white, deep red, and bright red. The best of each of these sorts is that which, when rubbed between the fingers, yields a grating sound. That, also, which is earthy, and does not possess the roughness above named, is fit for the purpose, if it merely leave a stain or any particles of earth on a white garment, which can easily be brushed away. If there be no sand-pits where it can be dug, river sand or sifted gravel must be used. Even sea sand may be had recourse to, but it dries

Informe de la Mision de la V. y M. Sta Barbara sita en el canal de la dicha Sta, asi de lo espirl como de lo temporal. Comprehende desde el dia 1. de enero del año 1791. hasta el dia 31. de Diciembre del expresado año. . . .

Fabricas. Se han fabricado 4. quartos. El uno de 10 vs de largo, y 6. de ancho: este sirve de guardia pa los soldados. Los tres pa guardar los instrumentos del campo, y carpinteria. Todos de adoves, y cubiertos de teja. . . .

Mision de Sta Barbara 31. de Diciembre del año 1791.
Fr Antonio Paterna   Fr Jose de Miguel

Informe de la M͂ion de la V. y M. Sta Barbara, sita en el Canal de la dicha Sta, asi de lo espirl, como de lo temporal, y comprehende desde el dia 1. de enero del año 1792, hasta el dia 31. de Diciembre del expresado año. . . . .

Fabricas. Se han hecho dos corrales, uno pa ganado mayor, y otro pa ganado menor, ambos de piedra. El primo tiene de largo 90. vs, y de ancho 75: el segundo 75. de ancho, y 50. de largo. . . . .

Mision de Sta Barbara 31. de Diciembre de 1792.
Fr Antonio Paterna   Fr Jose de Miguel

Informe del Estado de esta Mision de la Virgen y Martir Sta Barbara en 31. de Diciembre del año 1793. . . . .

Fabricas. Se ha fabricado una Iglesia de adoves de 45. vs de largo, y 9. y quartos de ancho. Una sacristia de adoves de 9. vs y quarta de largo, y 5. de ancho: ambas piezas estan techadas de teja, y enjarradas de mescla por dentro y fuera. Un Portico al frontis de la Iglesia de ladrillo, y techado de lo mismo, y de teja.

Mision de Sta Barbara 31. de Diciembre de 1793.
Fr Estevan Tapis   Fr Jose de Miguel

---

very slowly; and walls wherein it is used must not be much loaded, unless carried up in small portions at a time. It is not, however, fit for those walls that are to receive vaulting. In plastered walls, built with sea sand, the salt which exudes destroys the plaster; but plaster readily adheres to and dries on walls built with new pit sand, and vaulting may safely spring from them. If sand have been dug a long time, and exposed to the sun, the moon, and the rain, it loses its binding quality, and becomes earthy; neither when used does it bind the rubble stones together so as to prevent them sliding on their beds and falling out: nor is it fit to be used in walls where great weights are to be supported. Though pit sand is excellent for mortar, it is unfit for plastering; for being of a rich quality, when added to the lime and straw, its great strength does not suffer it to dry wtihout cracks. The poorness of the river sand, when tempered with beaters, makes the plastering as hard as cement. . . . .

"*Chapter V.—Of Lime.* Having treated of the different sorts of sand, we proceed to an explanation of the nature of lime, which is burnt either from white stone or flint. That which is of a close and hard texture is better for building walls; as that which is more porous is better for plastering. When slaked for making mortar, if pit sand be used, three parts of sand are mixed with one of lime. If river or sea sand be made use of, two parts of sand are given to one of lime, which will be found a proper proportion. If to river or sea sand, potsherds ground and passed through a sieve, in the proportion of one third part, be added, the mortar will be better for use. . . . .

"*Chapter VII.—Of Stone Quarries.* I have described the different species of lime and sand, and their qualities. Stone quarries, from which square and rubble stones are procured and prepared for the purposes of building, will now be considered. The qualities of these differ very much. Some stone is soft; . . . . . some moderately so. . . . . Others are hard. . . . . The soft species have this advantage, that when recently taken from the quarry they are easily worked, and answer well under cover; but when used in open and exposed situations, and subjected to the action of the frost and rain, they soon become friable, and moulder away. They are also much affected by the salt near the sea-shore, and are not capable of preserving their strength when exposed to great heat. . . . .

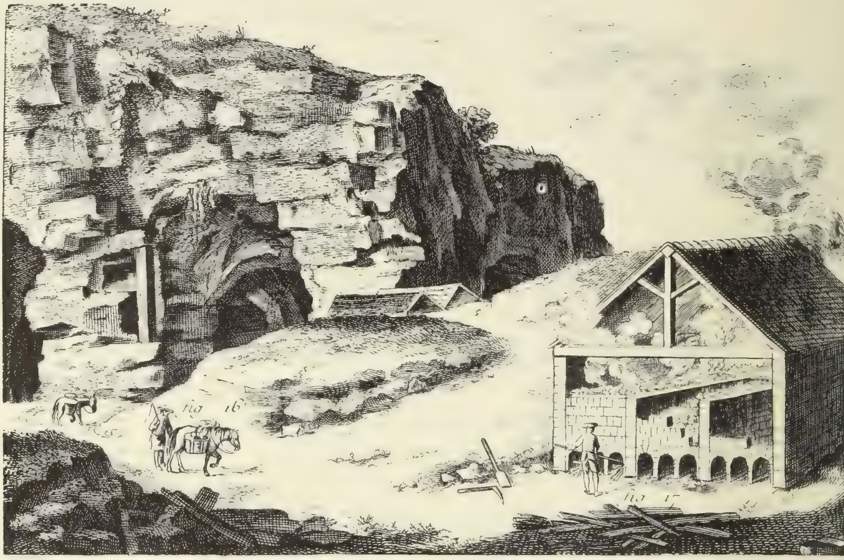


FIGURE 2. CARRIER—PLATRIER—La vignette représente une partie de carriere dans une colline escarpée; la masse en est percée par différentes rues d'où l'on a tiré la pierre de plâtre, que l'on conduit sur des bêtes de somme (fig. 16.) au four (fig. 17.) From *Encyclopédie—Recueil de planches, sur les Sciences, les Arts Liberaux, et les Arts Méchaniques, avec leur explicacion, par Denis Diderot. Paris, Brisson. M. DCC. LXII. Photo courtesy of California State Library.* [QUARRYMAN—The illustration shows part of a quarry in a steep hill; the mass is pierced by various openings from which the quarryman has removed the gypsum, which is transported on beasts of burden to the oven.]

Informe del estado de esta Mision de la Virgen, y Martir Sta Barbara de 31. de Diciembre del año 1794. . . . .

Fabricas. Se ha hecho una Troj de adoves de 26. varas de largo, y 7. de ancho; y otra pieza tambien de adoves pa Telar, de 18. vs de largo, y 7. de ancho, con su patio de adoves de 10. vs de ancho y 18. de largo. El cimiento de estas fabricas es de piedra, y mescla. Está todo techado de teja, y la mayor parte ripiado, y revocado con mescla por afuera. Item: un cemento, o Campo Sto de adoves de 45. vs de largo, y 16. de ancho bardeado de teja. Item: un corral de adoves pa las borregas de 62. vs de largo en quadro, y de 3. de alto, y bardeado de teja. . . . .

Mision de Sta Barbara 31. de Diciembre de 1794.

Fr Estevan Tapis — Fr Jose de Miguel

Informe del estado de esta Mission de la Virgen, y Martyr Sta Barbara de 31. de Diciembre de 1795. . . . .

Fabricas. Se han renovado dos lienzos y medio de los tejados del quadro de la Mission, quitando vigas y marrillos de alamo, y elizo, casi todo podrido, substituyendo vigas, y marillos de pino. Se han añadido ã las viviendas de los PP. Missioneros 4. quartitos 25. varas de largo y tres ancho con tres tabiques pa dividirlos. Los dos sirven de alcobas para dormir, y los otros 2. pa estudio. estas obras son por la mayor parte de mescla, piedra, y ladrillo. . . . .

Mission de Sta Barbara 31. de Diciembre de 1795.

Fr Estevan Tapis — Fr Jose de Miguel

FIGURE 3. . . . . . la Planche représente des maçons diversement occupés; les uns A à monter des pierres taillées; d'autres B sur un échafaut à enduire un mur de platre; d'autres C, à construire un ouvrage de maçonnerie. On voit en D & en E deux tailleurs de pierre; en F, ceux qui préparent la chaux; en G, un scieur de pierre; en H, I, K, les manoeuvres occupés à servir dans la construction des bâtimens. Bernard Fecit. From *Encyclopédie—Recueil de planches, sur les Sciences, les Arts Liberaux, et les Arts Méchaniques, avec leur explicacion, par Denis Diderot. Paris, Brisson. M. DCC. LXII. Photo courtesy of California State Library.* [This plate shows masons at their various tasks: A, raising the cut stones; B, from a scaffold, applying plaster to the wall; C, constructing a work of masonry; D and E, shaping the stone; F, preparing the lime; G, sawing the stone; H, I, K, other tasks performed during the construction of buildings.]

Informe del Estado de esta Mission de la V. y M. S^ta^ Barbara de 31. de Diciembre de 1796. . . . .

Fabricas. Se quitaron de 6. quartos de la Mission las vigas, y. marillos de alamo, y eliso, q^e^ por carcomidos amenazaban ruina, y se substituyeron en su lugar vigas, y marillos de pino. Quedan ya todas las fabricas de la Mission con madera de pino. Se hizo un corredor de 3. varas de ancho, y 45. de largo con pilares de ladrillo, y mescla, y techado de teja, p^a^ defender de las aguas ã la pared que mira al Presidio. Se hizo otro corredor de 3. varas de ancho, y 18. de largo con pilares de adoves, y techado de teja, en el patio del telar; y tambien hicieron en los dos extremos del corredor dos quartitos de adoves de 3. varas de ancho, y 6. de largo. . . . .

Mission de S^ta^ Barbara 31. de Diciembre de 1796.
F^r^ Estevan Tapis F^r^ Jose de Miguel

Informe del estado de esta Mission de la Virgen, y Martyr S^ta^ Barbara de 31. de Diciembre de 1797. . . . .

Fabricas. Se han fabricado 3. troges de 25. varas cada una; un quarto de 6. varas, q^e^ sirve de entrada ã dos de las troges; un quarto de 10. v^s^ para el jato, otro de 9. varas para la fragua, y otro de la misma medida para gallinero. Todas estas piezas tienen sus puertas, y chapas. Son de 6. v^s^ de ancho, de adoves, revocadas por fuera con mescla, y techados con teja; y aunq^e^ forman un quadro distinto, se entra ã el por el antiguo de la Mission. . . . .

Mission de S^ta^ Barbara 31. de Diciembre 1797.
F^r^ Estevan Tapis F^r^ Jose de Miguel

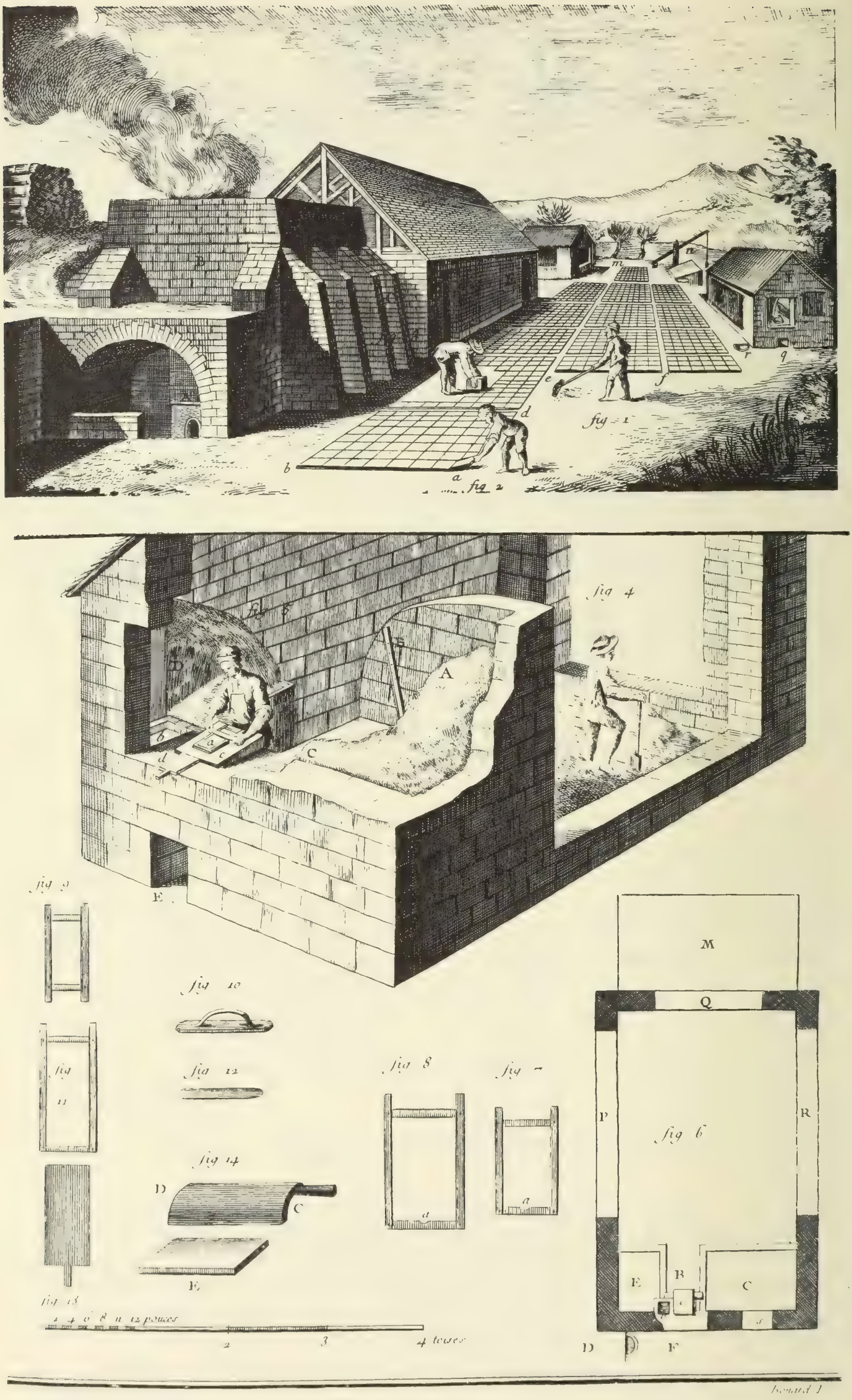


fig 1
fig 2
fig 4
A
B
C
D
E
fig 9
fig 10
fig 11
fig 12
fig 14
fig 13
fig 8
fig 7
fig 6
M
Q
P
R
E
B
C
D
F
2 4 6 8 10 12 pouces
2
3
4 toises

Tuilerie

TUILERIE.

PLANCHE Iere

LA vignete repréſente une tuilerie & tous les bâtimens néceſſaires.

A, B, C, le fourneau adoſſé à un terrein élevé par lequel on monte au-deſſus. Les murailles ſont fortifiées & ſoutenues par des contre-forts C, C, entre leſquels il y a deux portes pour entrer dans le fourneau. *Voyez* l'explication de la Planche III.

D, E, la halle dans laquelle on calibre le carreau & on le met ſécher à l'ombre, ainſi que la tuile. F, moulerie. Elle a pluſieurs ouvertures ou fenêtres. Le mouleur, qui eſt au-dedans de ce bâtiment, donne au coucheur les tuiles ou planchettes à meſure qu'il les a moulées. La fenêtre S fermée par une toile pendante, ſert à introdnire le ſable dont le mouleur a beſoin pour ſécher ſon moule & le bloc ſur lequel il travaille. L'ouverture *q* ſert à tirer au dehors le ſable qui tombe aux piés du mouleur. Les autres ouvertures *p*, auſſi fermées par des toiles, répondent à la partie de ce bâtiment où on marche la terre glaiſe. Derriere ce bâtiment eſt une foſſe dans laquelle on détrempe la terre glaiſe. On voit une de ces foſſes en *m*; elle eſt ordinairement entourée de glaiſe ſeche & concaſſée en petits morceaux. *r*, tonneau ou baquet rempli d'eau, & enterré de preſque toute ſa hauteur, & à moitié recouvert par une planche. Le coucheur y trempe les planchettes ſur leſquelles il tranſporte la tuile. *n*, petit pont & baſcule ſervant à puiſer l'eau néceſſaire, qui coule par des rigoles dans les foſſes à tremper.

Fig. 1. Ouvrier qui prépare & applanit une aire ou place *d*, *e*, *f*, couverte de ſable, pour mettre ſécher les moulées.

2. Coucheur qui étend ſur la place *a*, *b*, *d*, les tuiles ou planches de terre que le mouleur lui a fournies; il les tranſporte en ſe ſervant de petits ais de bois qu'on nomme auſſi *planchettes*, ſur les aires ou places où il les laiſſe ſécher.

3. Leveur qui raſſemble les planches ou tuiles quand elles ſont preſque ſéches, pour les tranſporter dans la halle couverte D, E.

4. Ouvrier qui marche la terre glaiſe, c'eſt-à-dire qui la pétrit avec les piés. La terre ſuffiſamment corroyée, eſt tranſportée à la pelle ſur le banc à-terre qui eſt à droite du mouleur.

5. Le mouleur placé debout devant le bloc *c*, & entre les deux maſſifs E, C, qu'on nomme *bancs*. Le premier eſt deſtiné à recevoir la terre corroyée qu'on voit en D; & le ſecond C, le ſable A avec lequel il ſaupoudre le moule & le bloc ſur lequel il travaille. Le ſable eſt retenu ſur le banc par des planches appuyées ſur le talleau B, & un ſemblable fixé à la muraille oppoſée. *a*, planchette que le mouleur applanit avec le racle. *b*, l'auget plein d'eau, dans lequel le mouleur met tremper le racle. *d*, planchette de bois avec laquelle le coucheur tranſporte les planches pour les faire ſécher ſur les aires ou places. E, ouverture par laquelle on retire le ſable qui eſt tombé aux piés du mouleur.

6. Plan de l'attelier du mouleur. M, la foſſe où on détrempe la terre glaiſe. Q, fenêtre par laquelle on la jette dans la marche, qui eſt l'eſpace entre P & R. P, R, ouvertures pour entrer dans la marche: on les ferme avec des toiles. E, banc-à-terre. B, place du mouleur. C, banc à ſable. *s*, fenêtre par laquelle on jette le ſable ſur le banc. *c*, bloc. *b*, l'auget. F, place du coucheur. D, tonneau ou baquet plein d'eau, dans lequel le coucheur trempe ſes planchettes.

7. Moule à tuile de petit moule. Ce chaſſis, qui a un demi-pouce d'épaiſſeur, a intérieurement neuf à dix pouces de longueur ſur ſix de large. Il a une échancrure *a* qui reçoit la terre avec laquelle le coucheur forme le crochet de la tuile.

8. Moule pour la tuile du grand moule. Il a ſept lignes d'épaiſſeur, treize pouces de long & huit de large, & auſſi une échancrure *a* pour former le crochet de la tuile.

9. Moule pour la brique. Il a intérieurement un pouce deux lignes d'épaiſſeur, huit pouces de long & quatre pouces de large.

10. La plane avec laquelle le mouleur étend la terre dans les moules à tuile, & dont il ſe ſert comme l'ouvrier (*fig.* 5.) ſe ſert du racle: il y en a de différentes grandeurs.

11. Moule à planche dont on fait le carreau. Il a intérieurement douze pouces de long ſur ſix de large, & ſept lignes d'épaiſſeur pour la planche dont on fait le carreau de petit moule. On ſe ſert d'un plus grand pour la planche dont on fait le carreau du grand moule.

12. Racle: il eſt de bois, comme tous les autres outils, & ſert au mouleur pour applanir la terre dont il forme les planches.

13. Planchette avec laquelle le coucheur (*fig.* 2.) tranſporte les planches de terre glaiſe ſur les places pour les faire ſécher. Il y en a de plus longues & de plus larges pour la tuile.

14. Ploior ſur lequel le leveur (*fig.* 3.) tranſporte la tuile faîtiere, & ſur lequel il lui fait prendre la courbure convenable. C, la poignée du ploior. E, la tuile.

FIGURE 4. *From Encyclopédie—Recueil de planches, sur les Sciences, les Arts Liberaux, et les Arts Méchaniques, avec leur explicacion, par Denis Diderot. Paris, Brisson. M. DCC. LXII. Photos courtesy California State Library.*

[TILE-WORKS—PLATE I. The illustration shows a tilery, and all the necessary buildings. *A, B, C,* The furnace, backed against elevated ground, by which one climbs above it. The walls are braced and supported by the buttresses C,C, between which there are two doors into the furnace. . . . . *D, E,* Drying shed, where clay products are stacked and dried in the shade. *F,* Moulding room. It has several openings or windows. The moulder, who is inside the building, gives the off-bearer the tiles or slabs as they are moulded. The window *S*, closed by a curtain, is where the sand is introduced which the moulder needs to dry his mould and the block on which he works. The sand that falls at the moulder's feet is removed through the opening *q*. The other openings, *p*, also closed by curtains, open into the part of the building where the clay is worked. Behind the building is a pit in which the clay is tempered. One of these pits can be seen at *m*; it is ordinarily surrounded by dried and pulverized clay. *r*, Cask or tub filled with water; it is nearly buried, and half covered by a board. Here the off-bearer dampens the planchettes on which he carries the tile. *n*, Small well-sweep for drawing up the necessary water, which flows

Informe del Estado de esta Mission de la Virgen, y Martyr Sta Barbara de 31. de Diciembre de 1798. . . . .

Fabricas. Se han fabricado de adoves, 19. quartos para otras tantas familias de Neofitos. Cada uno tiene de ancho 4. varas, y 6.½. de largo. Tienen todos su puerta, y ventana para cerrar; y estan revocados por fuera con mescla, y por dentro blanqueados con lechada de cal; y techados con teja. Se ha hecho de cajon, o tapia, una cerca de 3. varas de alto, y 2100. de circumferencia, bardeada con teja, para huerta, viña, y arboles frutales. . . . .

Mission de Sta Barbara 31. de Diciembre 1798.
Fr Estevan Tapis   Fr Juan Cortes

Ynforme del estado de esta Mision de la Virgen y Martir Sta Barbara de 31. de Diciembre de 1799. . . . .

Fabricas. Se ha fabricado de Adoves una Troj de 45. varas de largo, y. 6.½. de ancho, techada con teja, y revocada por dentro y fuera con mezcla. . . . .

Mission de Sta Barbara 31. de Diciembre de 1799.
Fr Estevan Tapis   Fr Juan Cortes

---

through small trenches into the tempering pits. *Fig. 1.* Worker who prepares and smoothes an area *d, e, f,* covered with sand, on which to dry the articles moulded. *Fig. 2.* The off-bearer, who lays out in the area *a, b, d* the tiles or slabs of clay that the moulder has turned out; he uses small wooden boards called *planchettes* to carry them to the drying area. *Fig. 3.* Worker who gathers the slabs or tiles when they are almost dry and puts them in the covered drying shed *D, E. Fig. 4.* Worker who tramples the clay, that is to say, who kneads it with his feet. The clay, when sufficiently mixed, is shoveled onto the bank of earth at the moulder's right. *Fig. 5.* The moulder stands before the block *c,* and between the two piles *E* and *C,* called *banks.* The first contains tempered clay, as shown in *D;* the second, *C,* contains the sand *A,* with which he sprinkles the mould and the block on which he works. The sand is held in a bank by the boards attached to the support *B,* and to a similar support fixed on the opposite wall. *a,* Slab of clay which the moulder smooths with the scraper. *b,* Trough filled with water, in which the moulder dips the scraper. *d,* Wooden paddle with which the off-bearer transports the slabs to the drying place. *E,* Opening for removing the sand that falls on the floor at the feet of the moulder. *Fig. 6.* Plan of the moulder's workshop. *M,* Pit where the clay is tempered. *Q,* Window through which the tempered clay is thrown into the workroom, which is the area between *P* and *R. P, R,* entry-ways into the trampling room; they are closed by curtains. *E,* Bank of earth. *B,* Moulder's stall. *C,* Bank of sand. *s,* Window through which sand is thrown on the bank. *c,* Block. *b,* Small trough. *F,* Position of the off-bearer. *D,* Cask or tub filled with water, in which the off-bearer dips his carrying-board. *Fig. 7.* Mould for small tile. Interior measurements of this frame are thickness, 1/2″; length, 9/10″; width, 6″. There is a semicircular cut *a* that holds the clay with which the off-bearer forms the tongue of the tile. *Fig. 8.* Mould for large tile, 7/12″ thick, 13″ long, 8″ wide. It has a semicircular cut *a* to form the tongue of the tile. *Fig. 9.* Brick mould. Interior dimensions thickness, 1-1/6″ length, 8″; width, 4″. *Fig. 10.* Plane with which the moulder spreads clay in tile moulds, and which he uses like the worker in fig. 5 uses the scraper. They are different sizes. *Fig. 11.* Wooden brick mould. The small-brick mould has interior dimensions of 12″ in length by 6″ in width, and is 7/12″ deep. A larger mould is used for larger bricks. *Fig. 12.* Scraper is of wood, as are all the other tools; it is used to smooth the slab of clay. *Fig. 13.* Small board on which the off-bearer (fig. 2) carries the slabs of clay to the drying place. It is longer and wider for tile. *Fig. 14.* Shaper for carrying and curving rounded tile. *C,* Handle of shaper. *E,* The tile.]

Ynforme del estado de esta Mision de la Virgen y Martir Sta Barbara de 31. de Dici. de 1800. . . . .

*Fabricas.** Se han fabricado 31. casas de adoves para habitacion de otras tantas familias de Neofitos, semejantes en todo ã las 20 que estaban ya fabricadas. Todas estan techadas con teja, revocadas por fuera con mescla, y blanqueadas por dentro con lechada de cal. Tienen sus puertas, y ventanas, y estan construidas en forma de calle. Tambien se han hecho corredores con pilares de ladrillo, y mescla, techados de teja, en tres lienzos del quadro de la Mision; los quales quedan enladrillados. . . .

Mision de Sta Barbara 31. de Diciembre de 1800.
Fr Estevan Tapis Fr Juan Cortés

* In October of 1800 Fathers Tapis and Cortés of Mission Santa Barbara wrote to Fr. Presidente Fermin Francisco de Lasuen, defending their management of the mission, in reply to the criticism of Comandante Felipe Goycoechea, who had expressed his opinion of mission affairs in answers to fifteen questions put to him by Governor Borica. The Fathers set forth their defense in *Replica de los Ministros de Sta Bárbara á la respuesta que dió el Comandante Goycoechea á las quince preguntas sobre abusos de los Misioneros,* and in their comments on Goycoechea's answer to question 9 presented the following data on construction work done by the neophytes:

"P . . . . 9 . . . . Que numº de horas hacen trabajar á los Yndios; y si tambien obligan ejecutarlo á las Yndias embarazadas, á las qe estan Criando, á las Viejas, y á los Ninos.

". . . . . Para qe se entienda el gran trabajo qe pondera el Sr Comte en los qe tienen tarea las explicaremos todas con claridad y distincion. A las mugeres no se les de mas tarea, q. es moler; y muele cada una en el dia 2 alms de trigo pa el Atole; y qdo es pa pan, muelen 8 y á veces 9 mugeres, 7 alms de trigo remojado. A los hombres se les da tarea en los adoves: hacen entre 9. 360 adoves de 2 tercias de largo, y una de ancho, q. repartidos en los 9 Yndios tocan 40 á cada uno. La tierra es blanda, y la agua al pié. Los q. trabajan en esta tarea jamas trabajan despues delas 11 y jamas el Sabado, y muchas veces ni el Viernes, por q. en los primeros dias de la Semana han adelantado las tareas de los ultimos. Los q. hacen teja trabajan con tarea. Se señalan 16 hombres jovenes, y á veces otros tantos medio viejos, o los qe se encuentran en la Rancha; y toda esta gente con dos mugeres, q les acarrean arena, y boñiga, hacen 500 tejas al dia, teniendo las pilas del barro immediatas, y siempre llenas. Estos Yndios acaban su tarea antes de las onze, y no obstanto adelantan siempre la tarea del Sabado, que les queda libre para pasear, ó descansar . . . . . Aora cotejaremos las de adoves, y tejas con los del Presidio. El año de 1795, pidio el Sr Comte de Presidio Dn Felipe Goycoechea, 10 Yndios, pa hacer teja. Se le señalaron los 10 mas dieztros, y mas utiles pa el trabajo, de los quales casi todos actualmte viven. A los 4 dias de trabajo en el Presidio, que fue el jueves. Se quejaron qe no podian aguantar el trabajo, y qe tenian las manos, y brazos muy doloridos. Se les pregunto que tarea hacian al dia; y respondieron que 500 tejas, repartidos en arrancar el barro Echarlo á las pilas. Echarle aqua ó de un pozo de 15 vs de profundo ó de una laguna algo distante, traer dela playa qe dista del parage donde hacian la teja medio quarto de legua, y boñiga, amazar el barro; y en fin de la mañana á la noche ellos solos tenian qe dejar bien hechos 500, por tener al soldado Olivas de sobre estante para qe no se perdiese el trabajo. Paresia increibile este trabajo tan recio, ye se temia fuese algun engaño de Yndios: con todo se les con soló alentandolos á que continuasen el viernes repitieron con mas insta la queja, añadiendo, q. aquel dia habian hecho trabajar 525. tejas. Ya entonces se les dijo, qe tomaran pacienca el dia siguiente y qe se haria pr relevar los de tanto trabajo. Vino á Mision el mismo Sabado el Sr Comte: se le hizo presente la queja de los Yndios, y respondio, q. esta era la tarea q. antes hacian los soldados. Se le propuso qe se pusieran 10 soldados escojidos con los mismos 10 Yndios, pa ver de la mañana á la noche quienes dejaban mas teja hecha, y no convino en esto, sino en qe no bajaran mas los Yndios por tener teja sufice. En quanto á los adoves qe deve hacer el Yndio qe trabaja á jornal, dejo declarando el Sr Arrillaga al año 1793; hallandose en esta Peninsula de Governador interino, qe debian ser 50 de tarea diaria. El año proximo pasado Dn Jose Ma Ortega, quien se hallaba de Sargº, pidio peones á la Mision, para qe le hicieran adoves y se le levantara una casa fuera del Presidio. Se la concedieron con la avertencia, qe la tarea habia de ser de 50 Adoves no mas cada individuo, segun lo qe tenia declarado el mensionado Sr Arrillaga. Condescendio á la condicion, pero dio en el arbitrio de mandar hacer una adovera de 3 quartas de largo, y media vara de ancho, y á proporcion mas alta que las ordinarias, qe han sido en la tierra de dos tercias de largo, y una de ancho. La agua tenian qe sacar de un pozo de mas de 12 varas de profundidad. De estas 2 tareas y acabamos de referir, podra juzgar

Ynforme del estado de esta Mision de la Virgen, y Martir S^{ta} Barbara del año 1801. . . . .

Fabricas. Se han fabricado 31. casas de adoves para habitacion de otras tantas familias de los Neofitos, en todos semejantes ã las 51. que en los dos años anteced^{s} se habian fabricado. Tambien se ha hecho otra casa de 21. varas de largo, y 6. de ancho, con su corredor; repartida en recamara, sala, cocina, y gallinero, techado todo con teja, y revocado con mezcla. . . . .

Mision de S^{ta} Barbara 31. de Diciembre 1801.
F^{r} Estevan Tapis — F^{r} Juan Cortes

Ynforme del estado de esta Mision de la Virgen y Martir S^{ta} Barbara del año 1802. . . . .

Fabricas. Se han fabricado 31. casas de adoves para habitacion de otras tantas familias de los Neofitos, en todo semejantes ã las 82, que en los 3. años anteced^{s} se habian fabricado, y todas quedan cercadas por tres vientos con tapia de 3. v^{s} de alto, quedando dentro la cerca bastante campo para las casas que faltan. Tambien se ha fabricado de tapia, y adoves una pieza de 20. varas de largo, y 6. de ancho con 5. pilas de ladrillo y mezcla para curtir baquetos, y baquetillos; y contigua ã esta, se ha hecho una casa para el Mayordomo de 18. varas de largo, y 6. de ancho, repartida en cocina, sala, y recamara, todo con corredor. Ultimam^{e} se construyeron de tapia, y adoves 5. quartos para varios usos necesarios en la Mision, que por todos tienen 40. varas de largo, y 6. de ancho. . . . .

Mision de S^{ta} Barbara 31. de Diciembre 1802.
F^{r} Estevan Tapis — F^{r} Juan Cortes

Ynforme del Estado de esta Mision de la Virgen, y Martir S^{ta} Barbara del año 1803. . . . .

Fabricas. Se han fabricado 48 Casas de adoves para habitacion de unas tantas familias de los Neofitos, en todo semejantes a las 113. q^{e} en los años anteced^{s} se habian fabricado, y amas una Yglesia, en una Rancheria distante dos leg^{s} de la Mision, llamada San Mig^{l} de 22 Var^{s} de largo, y 9 de ancho, inc^{s} las pared^{s}. . . . .

Mision de S^{ta} Barbara, 31 de Diciembre de 1803.
F^{r} Estevan Tapis — F^{r} Juan Cortés

Ynforme del Estado de esta Mision de la Virgen, y Martir Santa Barbara del año de 1804. . . . .

Fabricas. Se han fabricado 37. Casas de adobes para habitacion de otras tantas fam^{s} de los Neofitos en todo semejantes a las 161. q^{e} en los años anteced^{s} se habian fabricado, y ha mas un patio grande de Cajon para varios usos de los Neofitos. . . . .

Mision de S^{ta} Barbara, y Diciembre 31 del año del Señor de 1804.
Fr. Juan Cortes — Fr. Marcos Amestoy

---

qualquiera desapasionado:¿ q^{e} trabajo ha de causar mas compasion; si el q^{e} sufren los Yndios en la Mision, ó el q^{e} sufren en el Presidio? . . . . . Todas las mugeres, q. se consideran utiles, contribuyen al acarreo de adoves, q^{do} no da abasto una carreta q. se destina p^{a} esto desde el principio de qualquiera fabrica, la q. muchas veces basta, por hacerse siempre los adoves cerca de las fabricas. Las mismas mug^{s} contribuyen el acarreo de ladrillo, y teja, poquisimas veces de piedra, y esta chica p^{a} emparejar los cimientos. El acarreo de lo demas p^{a} las fabricas es obra de los gañanes con sus bueyes, y de los arrieros con sus mulas. De los chiquillos q. tienen mas de 9. años de edad, unos se ocupan en escarmenar lana en los telares, y dar la lanzadera con canilla á los tejedores, otros en cuidar de dia la teja, y ladrillos, q. no los pisen los animales, otros en espantar los pajaros, y los mas en divertirse con sus juegos pueriles. . . . . Mision de S^{ta} Barbara 30 de Octubre de 1800. . . . . Fr. Esteban Tapis— Fr. Juan Cortes. . . . . Es copia del original. Fr. Esteban Tapis." From *Santa Barbara Archives, vol. 2, Bancroft Library, University of California.*

Ynforme de esta Misn de Sta Barbara del año 1805. . . . .

Fabricas. Se han fabricado dos piezas grandes para troxas y una del mismo tamaño para madera, y 36. casas para los Yndios con sus puertas y Ventanas en todo semexantes á las de los años pasados, y son por todas 234. . . . .

Misn de Sta Barbara, y Diciembre 31 de 1805.
Fr Marcos Amestoy — Fr Marcos Anto de Vitoria

Ynforme dela Misn de Sta Bárbara del año 1806. . . . .

Fabricas. Se ha fabricado un Tanque para recoger agua de 40 varas quadradas de ancho y 2 y media de alto todo de piedra y mezcla. . . . .

Mision de Sta Bárbara y Diciembre 31 de 1806
Fr. Marcos Amestoy. — Fr. José Anto Urresti

Ynforme dela Mision de Sta Bárbara del año de 1807. . . . .

Fabricas. Se han fabricado 18 casas de la Rancheria en todo semejantes a las de los años pasados y son 252. . Tan se han fabricado 4 casas con su cuerpo de guardia. Tbn una Presa de Cal y Canto. . . . .

Mision de Sta Ba y Diciembre 31 de 1807. . . . .
Fr. José Anto Urresti. — Fr. Marco Amestoy

Ynforme de la Mision de Stã. Barbara V. y M. del año de 1808. . . . .

Fabricas. Se ha fabricado una Fuente con su Labadero en beneficio de la humanidad, y una casa pa la Alfahareria. De lo qe esta comenzado, se dariá razon el año qe viene. . . . .

Mision de Stã. Barbara y Diziembre 31 de 1808.
Fr. Marcos Amestoy — Fr Luis Gil de Taboada

Ynforme de la Mn de Stã Barba del año de 1809. . . . .

Fabricas. Se ha aumentado por la parte qe mira ã la mar la habitn de los ps Mintros con pared de cal, y canto, y techo de Azoteas.

Mn de S. Barba y Dbre. 31 de 1809.
Fr. L. G. de T. — Fr. Marcos Amestoy

Ynforme anual de la Misn de Stã. Barba en 31 de Dbre. de 1810. . . . .

Fabricas. Se continua la qe se dixo el año pasado. . . . .

Mision de Sta. Barba y Dbre. 31 de 1810.
Fr. N — Fr. N

Ynforme anual de la Mision de Stã. Barbara en 31 de Dbre de 1811. . . . .

Fabricas. Se há concluido la habiton de los ps Mintros. qe se dixo el año 1809. con corredor de Arqueria de Piedra; y se ha comensado el frontispicio de la Stã. Yga del se dará razon quando se finalize. . . . .

Misn de Stã. Barba Dbre. 31 de 1811.
F. L. G. y F. M. A.

Ynforme anual de la Mision de Stã Barbara en 31 de Dbre de 1812. . . . .

Fabricas. Con los terribles terremotos del 21 de Dbre. y dias subsequentes há quedado la Mision bastantemte averiada, de suerte que todas sus Fabricas exigen exactos reconocimtos y algo dilatadas composiciones, especialmte la Stã Yglesia, que, previa la licencia del Gobierno es regular qe se haga nueva pr qe comparados los trabajos qe deben emprehenderse en su composicion con los de la reedificacion


Plano
Del territorio de la alta California construido por las mejores noticias y observaciones propias del Capitan de Fragata D. Jose Mª Narvaez.
año de 1830.
Esplicacion
Presidio.
Misiones.
Pueblo.
Rancheria.
Distrito de Monte
Distrito de Monterrey
Cienegas
Bahia de Monterrey
Puerto de S. Fran.

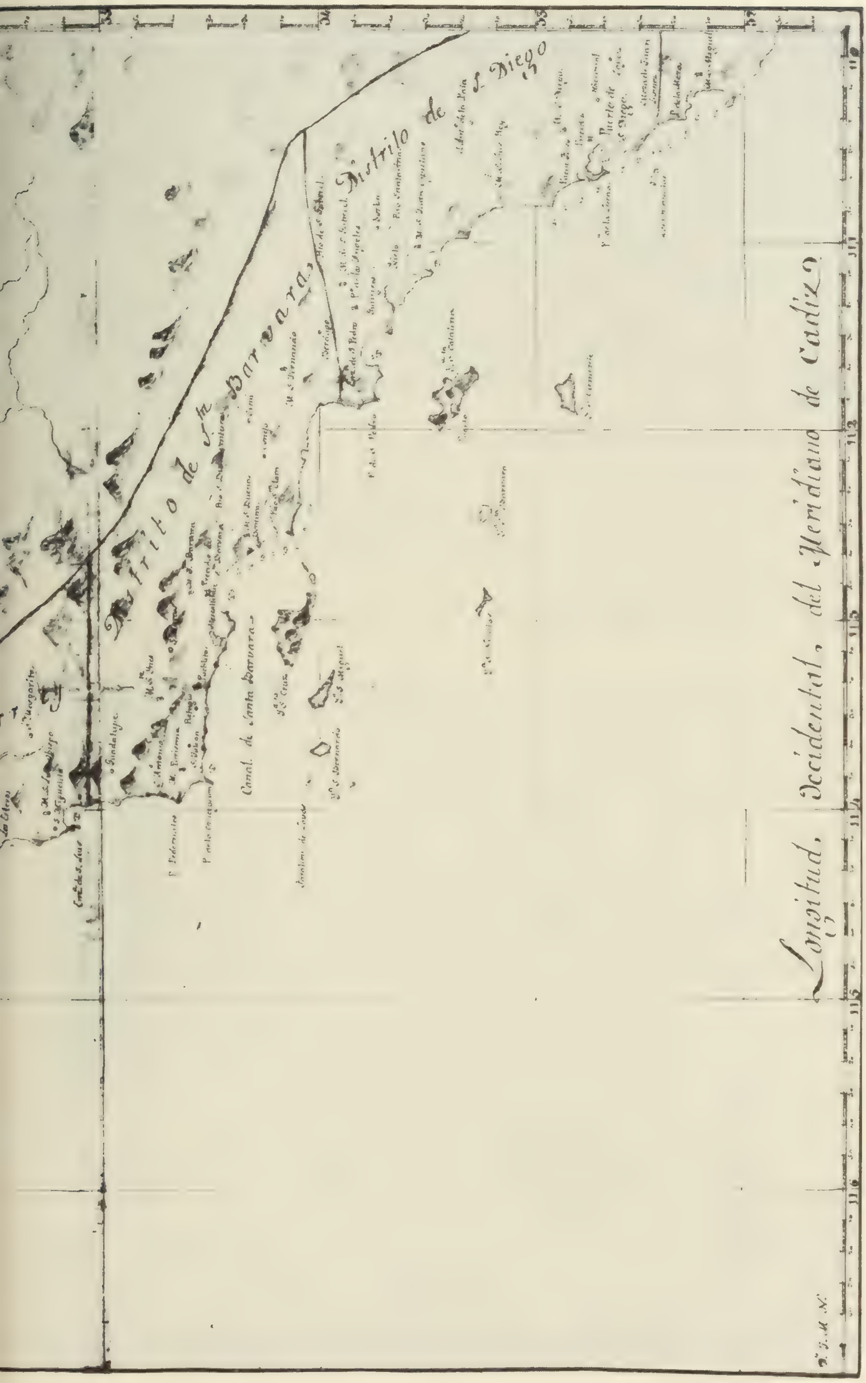


FIGURE 5. MAP OF ALTA CALIFORNIA, BY JOSE M. NARVAEZ. 1830. *From the collection of the California State Library.*

casí equiponderan pr añadiendo la poca satisfacion qe nos quedará de unas paredes remendadas, con la gñe. qe deben producirnos, unas nuevas, gruesas de cal, y canto, con sus respectivos solidisimos cimientos, ponderan mas los primeros qe los ultimos. . . . .

Mision de Sta. Barb. y Dbre. 31. de 812.

Fr. L. G. y F. M. A.

Ynforme del estado de esta Mision de Sta Barbara en el Año 1813. = 31. de Diciembre. . . . .

Fabricas. Subsisten las de los Años anteriores. . . . .

Fr. Ramon Olbès — Fr. Marcos Amestoy

Ynforme anual del estado de la Mision de Stã. Barbara en 31 de Dbrẽ. del 1814. . . . .

Fabricas. Se reedificó todo lo qe en la Rancheria habian derribado los Temblores, y lluvias. . . . .

Mision de Stã. Barbara, y Dbrẽ. 31 de 1814.

Fr. Luis Gil de T — Fr. Ramon Olbès

Ynforme del Estado de esta Mision de Sta Barbara V. y M en 31. de Dicbre de 1815. . . . .

Fabricas. . . . . Existe lo de los años anteriores, y se va reponiendo, y reparando lo qe el uso y Tiempo consumen.

Mision de Sta Barba 31. de Dicbrẽ de 1815.

Fr. Ramon Olbès — Fr. Antonio Ripoll

Ynforme del estado de esta Misn de Sta Barba V. y M. en 31 Dicbre de 1816. . . . .

Fabricas. . . . . Existen lo de los años anteriores, y se va reponiendo y reparando lo qe el uso, y tiempo consumen.

Mision de Sta Barba y Dicbre 31. de 1816.

Fr. Franco Suñer — Fr. Anto Ripoll

Ynforme del estado de esta Mision de Sta Barba V. y M. en 31. de Diciemb. de 1817. . . . .

Fabricas, utensilios de casa, y Campo, arrieria, hato, y Carpinta. Existe lo de los años anteriores; y se han añadido 20. aparejos, varias erramientas de carpinteria, y se va reponiendo y reparando lo qe el uso y tpõ. consumen; y se levantó un lienzo de adove, qe contiene un atrox, hato, y unos cuartos pa quardar erramientas y utensilios de campo, qe ya hacia algs años se havia caydo por ser viejo, y de caxon; y tambn se ha techado y compuesto la mitad de la casa principal qe era de asotea, y la madera ya podrida.

Fr. Franco Suñer — Fr. Anto Ripoll

Ynforme del estado de esta Misn de Sta Barba V. y M. en 31. de Dic. de 1818. . . . .

Fabricas. . . . . Existen de los años anteriores y se ba reponiendo y reparando lo que el uso y tiempo consumen.

Mision de Stã. Barbara 31 de Diciembre de 1818.

Fr. Francisco Suñer — Fr. Antonio Ripoll

Ynforme del estado de esta Misn de Sta Barba Virgn y Martir en 31. de Dicbre de 1819 . . . .

Fabricas. . . . . Existe lo de los años anteriores, y se va reponiendo, y reparando, lo qe el uso y tpo consumen.

Mision de Sta Barba y 31 de Dicbre de 1819.

Fr. Franco Suñer — Fr. Anto Ripoll

Ynforme del estado de esta Mis^n de S^ta Barbara Virgen y M. en 31. Dic^bre de 1820. . . . .

Yglesia y Sacristia. La Ygl^a actual de esta Mis^n comenzada en el año 1815. se concluyo el presente año, cuya bendic^n se celebradó o verificó el dia 10. de Sept^bre del mismo; es de piedra labrada y mezcla, de paredes muy reforzadas, y buenos estribos, con su torre correspond^te de dos cuerpos, en donde se mantienen seis campanas, y tres de ellas esquilas; es de cielo raso enjarrado de yesomate con sus pinturas regulares jaspeadas las columnas, y mesas de los Altares á la Romana q^e son tres incluso el mayor, y en una de aquellas el pulpito correspond^te. Se puso en el frontis la Ymagen de la Patrona S^ta Barbara, en un nincho como sostenida de seis columnas, y en los remates del triangulo se han colocado las tres virtudes de Fé, Esperanza, y Caridad, cuyas cuatro figuras son todas de piedra labrada, y pintadas al oleo, y el piso de la Ygl^a as de betun bruñido por lo q^e queda muy aseada, con esto, y varios adornos q^e se han puesto asi en la Ygl^a como en la Sacristia parece queda agradable ã la vista, fuerte, y aseada. . . . .

Fabricas. . . . . Existe lo de los años anteriores, y se va reponiendo, y reparando lo q^e el uso y tiempo ha consumido.

Mision de S^ta Barb^a y 31. Diciembre de 1820.

Fr. Fran^co Suñer Fr. Ant^o Ripoll

FIGURE 6. RECEPTION OF LA PÉROUSE AT CARMEL MISSION. See also fig. 8. *Figures 6-11 from the collection of the Museo Naval, Madrid, courtesy of Julio F. Guillen, Capitán de Navío.*

FIGURE 7. VISTA DEL PRESIDIO DE MONTERREY. BRAMBILA. 1794. [View of the presidio of Monterey.] *Reproduced from Museo Naval Publicaciones I, Año 1932, by courtesy of the Museum.*

FIGURE 8. RESIVIMIENTO DEL CONDE DELA PEI RUS EN LA MISION DEL CARMELO MONTEREI. BRAMBILA. 1794. *Reproduced from Museo Naval Publicaciones I, Año 1932, by courtesy of the Museum.*

JEAN-FRANÇOIS GALAUP DE LA PÉROUSE

On the Indian Dwellings at Carmel Mission

September 1786 *

[English translation is on page 168.]

. . . . . Le 7, le brouillard fut encore plus épaìs que le jour précédent; il s'eclaircit cependant vers midi, et nous vîmes des sommets de montagnes dans l'est, à une assez grande distance. Comme notre route avait valu de sud, il est évident que, depuis les 42d, la côte commence à fuir dans l'est. Notre latitude nord fut observée à midi; elle était de 40d48′30″: notre longitude occidentale, suivant les horloges, était de 126d59′45″. Je continuai à faire route pour approcher la terre, dont je n'étais qu'à quatre lieues à l'entrée de la nuit. Nous apperçûmes alors un volcan † sur la cime de la montagne qui nous restait à l'est; la flamme en était très-vive: mais bientôt une brume épaisse vint nous dérober ce spectacle; il fallut encore s'eloigner de terre. Comme je craignais, en suivant une route parallèle à la côte, de rencontrer quelque isle ou rocher un peu

---

"The first intercourse of the Californians with subjects of a foreign power was with the French under Jean François Galaup de La Pérouse in the autumn of 1786. This distinguished navigator had sailed from Brest in August 1785 on the frigate *Boussole* with the *Astrolabe* under M. de Langle, on a scientific exploring expedition round the world, fitted out and despatched by the French government. A full corps of scientific specialists accompanied the expedition; minute and carefully prepared instructions were given, accompanied by reports and charts of all that had been accomplished by the explorers of different nations; the commanders were carefully selected for their ability and experience; and in fact every possible precaution was taken to make the trip a success. . . . . Having doubled Cape Horn, visited Easter Island and the Hawaiian group, the *Boussole* and *Astrolabe* crossed to the American coast, anchoring July 4, 1786, in the Port des Français in 58° 37′. . . . . On the voyage southward no observations were made on the California coast on account of the dense fogs, save that one night there was seen what seemed to be a volcano in active operation below 41°, until they entered Monterey Bay September 14th, anchoring next day among the whales which came boldly within pistol-shot to spout vile-smelling water round about the vessels. . . . . During the brief stay of ten days the crew were busy in obtaining wood and water; while the botanists, geologists, and other specialists pursued their studies, made drawings, and gathered specimens. . . . . On the 22d all was ready for departure, and farewell was said to governor and missionairies. Next day the winds were contrary, but early on the 24th the navigators . . . . . set sail for the far west. . . . . Crossing the Pacific the Frenchmen visited the Philippine Islands in February 1787; then they coasted Japan and China, and reached Kamchatka in September; at the Navigator Islands in December, M. de Langle, with eleven of his men, was killed by the Indians; and the last that was ever known of vessels, commander, or crew, they were at Botany Bay on the coast of New Zealand, where La Pérouse's journal ends with January 24, 1788, a subsequent letter being dated February 8th, at the same place." *H. H. Bancroft, History of California, vol. 1, 1542-1800, pp. 428-433, 1884.*

* From *Voyage de La Pérouse Autour du Monde, Publié Conformément au Décret du 22 Avril 1791, et Rédigé par M. L. A. Milet-Mureau, Général de Brigade dans le Corps du Génie, Directeur des Fortifications, Ex-Constituant, Membre de Plusieurs Sociétés Littéraires de Paris. Tome Premier, Tome Second, Tome Troisiéme, Tome Quatrieme. A Paris, Chez Plassan, Imprimeur-Libraire, Rue de Cimetière André-des-Arcs, nº 10. L'an vi de la République.—1798.*

† ". . . . . At half-past seven, we suddenly discovered, to the south-south-east, a considerable fire on Cape Mendocino; this fire covered the greater part of the hill, from the sea-shore to the summit, and it appeared to extend to the other side. . . . .

"Accurate inquiries at Saint Francisco, convinced me that this fire, which, at a distance, might have been taken for a volcano, must be ascribed to the Indians, as well as other less considerable, and more distant ones, which we saw that and the preceding nights. The natives at this season, set fire to the grass, to dry the pods of a grain which they use for food, to render it more easy to gather. It was, doubtless, this circumstance, which was unknown to our illustrious La Peyrouse, and that was the cause of his error, when seeing a great fire on Cape Mendocino, about the same time of the year, he thought it was a volcano. . . . ." Camille de Roquefeuil, September 1818; from *A Voyage Round the World Between 1816-1819. By M. Camille de Roquefeuil, in the Ship Le Bordelais. London: Printed for Sir Richard Phillips and Co.,Bride-Court, Bridge-Street. 1823.*

FIGURE 9. MISION DEL CARMELO DE MONTEREY. *Reproduced from the collection of the Museo Naval, Madrid, by courtesy of the Museum.*

FIGURE 10. PLAZA DEL PRESIDIO DE MONTE-REY. *Reproduced from the collection of the Museo Naval, Madrid, by courtesy of the Museum.*

FIGURE 11. VISTA DEL CONVENTO, YGLECIA, Y RANCHERIAS DE LA MISION DEL CARMELO. [View of the convent, church, and rancherias of Carmel Mission.] *Reproduced from the collection of the Museo Naval, Madrid, by courtesy of the Museum.*

écarté du continent, je pris la bordée du large. La brume fut très-épaisse. . . . .

. . . . . A trois heures après [14 Septembre 1786], nous eûmes connaissance du fort de Monterey, et de deux bâtimens à trois mâts qui étaient dans la rade. . . . .

Il est remarquable que, pendant cette longue traversée, au milieu des brumes les plus épaisses, l'Astrolabe navigua toujours à la portée de la voix de ma frégate, et ne s'en écarta que lorsque je lui donnai l'ordre de reconnaître l'entrée de Monterey. . . . .

. . . . . La paroisse est fort propre, quoique couverte en chaume; elle est dédiée à saint Charles, et ornée d'assez bonnes peintures, copiées sur des originaux d'Italie. . . . .

. . . . . La maison des missionaires, . . . est en face de la paroisse, ainsi que les différens magasins. Sur la droite est placé le village indien, composé d'environ cinquante cabanes qui servent de logement à sept cent quarante personnes des deux sexes, les enfans compris, qui composent la mission de Saint-Charles ou de Monterey.

Ces cabanes sont les plus misérables qu'on puisse rencontrer chez aucun peuple; elles sont rondes, de six pieds de diamètre sur quatre de hauteur; quelques piquets de la grosseur de bras, fixés en terre, et qui se rapprochent en voûte par le haut, en composent la charpente; huit à dix bottes de paille mal arrangées sur ces piquets garantissent bien ou mal les habitans de la pluie ou du vent, et plus de la moitié de cette cabane reste découverte lorsque le temps est beau: leur seule prècaution est d'avoir chacun, près de leur case, deux ou trois bottes de paille en réserve.

Cette architecture générale des deux Californies n'a jamais pu être changée par les exhortations des missionnaires; les Indiens disent qu'ils aiment le grand air, qu'il est commode de mettre la feu à sa maison lorsqu'on y est dévoré par une trop grande quantité de puces, et d'en pouvoir construire une autre en moins de deux heures. Les Indiens indépendans, qui changent se fréquemment de demeure, comme les peuples chasseurs, ont un motif de plus.

FIGURE 12. THE MISSION OF S^T CARLOS, NEAR MONTERREY. W. Alexander del: from a Sketch taken on the Spot by J. Sykes; B. T: Pouncy Sculp^t London. Published May 1^st 1798, by R. Edwards New Bond Street J. Edwards Pall Mall & G. Robinson Pater noster Row. *Photo by courtesy of California State Library.*

FIGURE 13. THE PRESIDIO OF MONTERREY. W. Alexander del: from a Sketch taken on the Spot by J. Sykes; B. T. Pouncy Sculp[t] London. Published May 1[st] 1798, by R. Edwards New Bond Street J. Edwards Pall Mall & G. Robinson Pater noster Row. *Photo by courtesy of California State Library.*

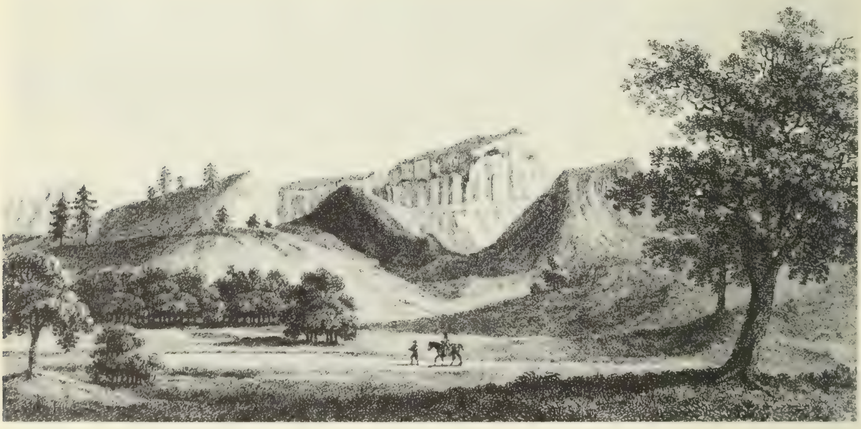


FIGURE 14. A REMARKABLE MOUNTAIN NEAR THE RIVER OF MONTERREY. W. Alexander del: from a Sketch taken on the Spot by J. Sykes; B. T. Pouncy Sculp[t] London. Published May 1[st] 1798, by R. Edwards New Bond Street J. Edwards Pall Mall & G. Robinson Pater noster Row. *Photo by courtesy of California State Library.*

CAPTAIN GEORGE VANCOUVER

On the Use of Stone at Carmel Mission

1792-94 *

1792. November. The decks of the Discovery, in consequence of the late inclement weather, were found to be excessively leaky, and to require caulking; many of the sails wanted material repair: these, with various other services, were put in a train of execution. On board the Chatham all were busily employed, particularly in recruiting their stock of provisions; as, in consequnece of my former intention, no more had been received on board than would be absolutely necessary for her passage home; it now however became requisite that both vessels should receive from the Daedalus as large a proportion of stores, provisions, &c. as each was capable of stowing.

December. Sunday 2. Having given proper directions for carrying these several services into effect, on Sunday the 2d of December, in consequence of a very polite invitation, I paid my respects to the mission of St. Carlos, accompanied by Senr Quadra, Senr Arguella, Senr Caamano, Mr. Broughton, and several other English and Spanish officers.

The establishment is situated about a league to the south-eastward of the presidio of Monterrey. The road between them lies over some steep hills and hollow vallies, interspersed with many trees; the surface was covered over with an agreeable verdure; the general character of the country was lively, and our journey altogether was very pleasant.

---

* From *A Voyage of Discovery to the North Pacific Ocean, and Round the World; In Which the Coast of North-West America Hàs Been Carefully Examined and Accurately Surveyed. Undertaken by His Majesty's Command, Principally With a View to Ascertain the Existence of Any Navigable Communication Between the North Pacific and North Atlantic Oceans; and Performed in the Years 1790, 1791, 1792, 1793, 1794, and 1795, in the Discovery Sloop of War, and Armed Tender Chatham, Under the Command of Captain George Vancouver. London: Printed for G. G. and J. Robinson, Paternoster-Row; and J. Edwards, Pall-Mall. 1798.*

"In April [1792] Captain George Vancouver in the *Discovery* with the *Chatham* under Lieutenant Broughton, on a grand exploring voyage round the world, had crossed over from the Sandwich Islands and made observations on the California coast as he sailed northward from just below Cape Mendocino. . . . . Six months later, coming from Nootka, the English navigator sailed down the coast without anchoring, and on November 14th, in the *Discovery*, entered San Francisco Bay at nightfall and anchored in front of Yerba Buena Cove. . . . . On the 16th by advice of the Spaniards . . . . . the *Discovery* was transferred to the usual anchorage nearer the presidio. . . . . Vancouver's reception at San Francisco was most cordial and satisfactory. . . . . On the 20th of November [he] and seven of his officers made an excursion on horseback to Santa Clara, being the first foreigners who had ever penetrated so far into the interior. . . . . After most hospitable treatment by fathers Peña and Sanchez at Santa Clara, they returned to San Francisco on the 22d. The *Chatham* had meanwhile arrived, and preparations were hastened for departure. . . . . The two vessels sailed away the 26th and anchored next morning at Monterey.

"Vancouver found lying at anchor in the harbor of Monterey the *Daedalus,* his store-ship which had joined the fleet at Nootka. . . . . The *Discovery* and the *Chatham* remained at Monterey for about fifty days for reloading and repairs. A tent and observatory for astronomical observations were set up on the beach, and the *Daedalus* sailed in December for New South Wales.

"Vancouver and party went over to San Cárlos the 2d of December, and were hospitably entertained, as La Pérouse had been six years before, by President Lasuen and the other friars. . . . . January 15, 1793 . . . . . the . . . . . English [ships] disappeared in the southwest behind Point Pinos and left to Monterey its usual solitude." *H. H. Bancroft, History of California, vol. I, 1542-1800, pp. 510-513, 1884.*

1792. December. Our reception at the mission could not fail to convince us of the joy and satisfaction we communicated to the worthy and reverend fathers, who in return made the most hospitable offers of every refreshment their homely abode afforded. On our arrival at the entrance of the mission the bells were rung, and the Rev. Fermin Francisco de Lasuen, father president of the missionaries of the order of St. Francisco in New Albion, together with the fathers of this mission, came out to meet us, and conduct us to the principal residence of the father president. This personage was about seventy-two years of age, whose gentle manners, united to a most venerable and placid countenance, indicated that tranquillized state of mind, that fitted him to an eminent degree for presiding over so benevolent an institution.

The usual ceremonies on introduction being over, our time was pleasantly engaged in the society of the father president and his two companions, the priests regularly belonging to the mission of St. Carlos, who attended us over their premises. These seemed to differ but little from those at St. Francisco,* or Sta Clara; excepting that the buildings were smaller, the plan, architecture, and materials exactly corresponding.

In their granaries were deposited a pretty large quantity of the different kinds of grain before noticed at the other establishments, to which was added some barley, but the whole was of an inferior quality, and the return from the soil by no means equal to that produced by Sta Clara. Here also was a small garden on the same confined scale, and cultivated in the same manner as observed at the other stations.

An Indian village is also in the neighborhood; it appeared to us but small, yet the number of its inhabitants under the immediate direction of this mission was said to amount to eight hundred, governed by the same charitable principles as those we had before visited. Notwithstanding these people are taught and employed from time to time in many of the occupations most useful to civil society, they had not made themselves any more comfortable habitations than those of their forefathers; nor did they seem in any respect to have benefitted by the instruction they had received. Some of them were at this time engaged under the direction of the fathers, in building a church with stone and mortar. The former material appeared to be of a very tender friable nature, scarcely more hard than indurated clay; but I was told, that on its being exposed to the air, it soon becomes hardened, and

---

* Archibald Menzies, who accompanied Captain George Vancouver on his voyage around the world, during which they several times touched the shores of Upper California, describes the Presidio of San Francisco as he saw it in 1792:

"It is situated on a gentle declivity about a quarter of a Mile from the sea side, & occupied a square space of ground about four hundred Yards on each side, walled in on three sides with Turf or Mortar Wall of twelve or fourteen feet high & rudely fenced in on the other or Eastern side with a dead hedge. The Walled part is lined on the inside with a row of shabby mean houses irreguarly built of the same materials & thatched with coarse long grass & bulrushes, as Habitations & Store houses for the Soldiers & their Families who were about thirty six in number under the command of the Governor as Commandant & a Serjeaunt. The Commandant's own dwelling could hardly be distinguished from the rest till we got on the inside of it, & then the friendly treat & hearty welcome we received from his Lady & Family made ample recompense for the poverty of its exterior appearance.

"The Houses & Wall of the Proesidio were built of Turf & Mortar in the form of large Bricks workd up & incorporated with Straw or Grass & afterwards dried in the Sun till they became hard & appeared to be durable." From the *Journal* of Archibald Menzies, published in part in the California Hist. Soc. Quart. vol. 2, no. 4, Jan. 1924, by Miss Alice Eastwood.

is an excellent stone for the purpose of building. It is of a light straw colour, and presents a rich and elegant appearance, in proportion to the labour that is bestowed upon it. It is found in abundance at no great depth from the surface of the earth; the quarries are easily worked, and it is I believe the only stone the Spaniards have hitherto made use of in building. At Sta Clara I was shown a ponderous black stone, that father Thomas said was intended to be so appropriated as soon as persons capable of working it could be procured. The lime they use is made from sea shells, principally from the ear shell, which is of a large size and in great numbers on the shores; not having as yet found any calcareous earth that would answer this essential purpose. The heavy black stone is supposed to be applicable to grinding, and should it be found so to answer, it will be a matter of great importance to their comfort, since their only method of reducing their corn to flour is by two small stones placed in an inclined position on the ground; on the lower one the corn is laid, and ground by hand by rubbing the other stone nearly of the same surface over it. The flour produced by this rude and laborious process makes very white and well tasted, though heavy bread, but this defect is said by the Spaniards to be greatly remedied when mixed with an equal proportion of flour properly ground. . . . .

1792. December. . . . . . The present presidio [Monterey] is the identical one that was built on the first establishment of this port in the year 1770, without having undergone the least improvement or alteration since that period. The buildings of the presidio form a parallelogram or long square, comprehending an area of about three hundred yards long, by two hundred and fifty yards wide, making one intire inclosure. The external wall is of the same magnitude, and built with the same materials; and except that the officers appartments are covered in with a sort of red tile made in the neighborhood, the whole presents the same lonely uninteresting appearance, as that already described at St. Francisco. Like that establishment, the several buildings for the use of the officers, soldiers, &c. and for the protection of stores and provisions, are erected along the walls on the inside of the inclosure, which admits of but one entrance for carriages or persons on horseback; this, as at St. Francisco, is on the side of the square fronting the church, which was rebuilding with stone like that at St. Carlos.* . . . .

1794. November. Wednes. 19. I was . . . on Wednesday able to join a party to the valley through which the Monterrey river flows, and was there gratified with the sight of the most extraordinary mountain I have ever beheld. On one side it presented the appearance of a sumptuous edifice fallen into decay; the columns which looked as if they had been raised with much labour and industry, were of great magnitude, seemed to be of an elegant form, and to be composed of the same cream-coloured stone,

* Menzies writes "They have no Lime here [Monterey region] but what they make from Shells, consequently their Houses are built with Stone & Mortar or with Sods & plaisterd with Mortar & afterwards White Washd; they are only one story high & generally divided into two apartments, in one of which a small place near the Wall is elevated about a foot higher than the rest of the floor on which a Mat is spread, & sometimes Cushions for the Women to sit down on, & if they take their seats before a stranger arrives, they never stir to pay the least homage to him."

of which I have before made mention. Between these magnificent columns were deep excavations, resembling different passages into the interior parts of the supposed building, whose roof being the summit of the mountain appeared to be wholly supported by these columns rising perpendicularly with the most minute mathematical exactness. The whole had a most beautiful appearance of human ingenuity and labour; but since it is not possible, from the rude and very humble race of beings that are found to be the native inhabitants of this country, to suppose they could have been capable of raising such a structure, its being the production of nature, cannot be questioned, and it may not be preposterous to infer, that it has been from similar phaenomena that man has received that architectural knowledge, by which he has been enabled to raise those massy fabricks, which have stood for ages in all civilized countries.

WILLIAM SHALER

On the Use of Lime and Stones in Repairing the Lelia Byrd March 1805 *

On the 24th of February, I arrived without any remarkable occurrence on the coast of California, where we got plentiful supplies of provisions as usual, and were not unsuccessful in our collections of furs. The 14th of March, I paid a visit to the island of Santa Catalina, where I had been informed, by the Indians, that there was a good harbour. We remained there a few days only, to ascertain that point. We found the harbour every thing that could be desired, and I determined that, after collecting all the skins on the coast, I would return to it and careen the ship, which she was by this time greatly in want of. After completing our business on the coast, we returned to Santa Catalina, and anchored in the harbour on the 1st of May. As I was the first navigator who had ever visited and surveyed this place, I took the liberty of naming it after my much-respected friend, M. De Roussillon. We warped the ship into a small cove, and landed the cargo and every thing moveable, under tents that we had previously prepared for their reception. The Indian inhabitants of this island, to the amount of about 150 men, women, and children, came and encamped with us, and readily afforded us every aid in their power.

* From *Journal of a Voyage Between China and the Northwestern Coast of America Made in 1804*, by William Shaler; published in the American Register, vol. 3, Philadelphia, 1808.

"Several American trading craft made their appearance on the California coast this year [1803], creating not a little excitement in some instances by attempts at smuggling, in the success of which the people were often hardly less interested than the Yankee captains. The *Lelia Byrd* was fitted out at Hamburg by Captain Richard J. Cleveland of Salem, Massachusetts . . . . in partnership with William Shaler, and sailed in November 1801. Shaler was master and Cleveland second in command. The vessel was loaded with a great variety of merchandise, which it was hoped to sell profitably on the west coast of America. . . . . After doubling Cape Horn . . . . . the navigators reached San Blas in July [1802]. Here and at the Tres Marías they waited over six months, and . . . . . succeeded not only in selling goods to the amount of $10,000 and obtaining what supplies they needed, but also bought 1,600 otter-skins just arrived from California at prices which assured the success of the trip. An amusing feature of this and other similar narratives is the cool frankness with which the Americans and English present the evasion of all Spanish commercial and revenue regulations as an action altogether praiseworthy, and the efforts of the officials to enforce those regulations as correspondingly reprehensible.

"Sailing from San Blas, January 25, 1803, after careening and 'boot-topping' the vessel at the Tres Marías, our adventurers sailed in February for San Diego. . . . . On the evening of

After caulking the ship's upper works, and paying, or rather plastering them with a mixture of lime and tallow, as we had no pitch, tar, or any resinous substance on board, we careened her. We found her bottom in a most alarming state: the worms had nearly destroyed the sheathing, and were found to be lodged in the bottom planks. I was now pretty well assured of what I had long before feared; that is, that she would not carry us back to Canton. We, however, repaired the first side in a tolerable manner, and paid it with a thick coat of lime and tallow; righted and hove out the other side, which we found far worse than the first. The keel and stern-post were nearly reduced to a honey-comb. It was necessary to heave her far out, in order to apply effectually such remedies as were in our power, but unfortunately we hove her rather too far, and she upset and filled. This was a sad misfortune. It did not discourage us, however, and we went to work with spirit and resolution to remedy it, and had the satisfaction of righting her the next day, without apparently having suffered any material damage. The day following we pumped and bailed out the water, and the day after hove the ship out a third time, but had the misfortune to find her leak so bad, that we were obliged to right her immediately. I next determined to lay the ship ashore at high water, and endeavor to repair her when the tide should leave her. This experiment was tried without effect, as she buried herself so much in the sand, as to put it out of our power to do any thing effectual; but the greatest misfortune was, that, as the tide came in again, we found the ship leak so bad, that both pumps were necessary to keep her free. This demanded an immediate remedy; and as the leak was known to be aft, I ordered the mizen-mast to be cut away in order to come at it. The leak was soon dis-

---

March 17th, the *Lelia Byrd* passed the fort at Point Guijarros without being hailed, and anchored in San Diego Harbor. . . . . It was known that the soldiers had small quantities [of otter skins] which they would gladly dispose of if they could do so without detection. Two boats were accordingly sent under cover of night to different parts of the bay shore. One returned with a few otter-skins; but the other was seized by the watchful commandant [Don Manuel Rodriguez], the mate and two men being bound and left on the beach under a guard of three men. Next morning Cleveland went ashore with four men, each armed with a brace of pistols, rescued the captives, and brought them off. Sails were set at once and the somewhat hazardous attempt was made of running out past the guns of the fort. The hoisting of a flag and the firing of a blank-cartridge from the battery had no effect, and when a nine-pound ball came across her bows the *Lelia* still kept on her course. . . . . As she passed the fort two broadsides from her six three-pounders were discharged at the battery; while many of the shots from on shore took effect in the rigging, and several struck the hull, one of them making an ugly hole between wind and water. . . . . The *Byrd* hastened to San Quintin for repairs, arriving on the 24th.

". . . . . The *Lelia Byrd* . . . . . [was] on the coast again in 1804 . . . . . under the command of her old captain, William Shaler, and brought a cargo which had been completed in China by buying out another American vessel. . . . . The *Lelia* from Canton arrived off the Columbia River May 1st, proceeding down the coast and anchoring in Trinidad Bay, California, on the 11th. . . . . Of the voyage down the coast from Trinidad we have the following only: 'On the 23d we arrived on the coast of California, where I got abundant supplies of provisions, and began a trade with the missionaries and inhabitants for furs. We continued on the coast of California until the 8th of July, when we sailed for the gulf of that name.'

"After a trip to Guaymas and down the coast to Guatemala Shaler turned northward, and on February 'arrived without any remarkable occurrence on the coast of California.' . . . . He visited Santa Catalina Island, found a desirable harbor, and again anchored there in May. . . . . The ship was found to be in an unseaworthy condition, but by six weeks of hard work, attended with many mishaps, and by a free and somewhat novel use of oakum, lime, and tallow, she was made ready, and sailed early in June. Shaler anchored in San Pedro Bay where he obtained supplies for twelve months . . . . . then he ran down the coast, collecting furs on the way; and July 30th sailed from Cape San Lúcas for the Sandwich Islands, where he arrived in August." *H. H. Bancroft, History of California, vol. 2, 1801-1824, pp. 10-23, 1886.*

covered by this means, but so situated that we could apply no other remedy than the lime and tallow that had been previously prepared for her bottom; this, mixed with oakum, was driven down on the leak, and we had the satisfaction to see it reduced by these means to one pump by the time she was afloat. We now burnt a large quantity of lime, which we made into stiff mortar, and put on the first, laying a platform of boards over it, and covering the whole with several tons of stones, to keep it firmly down. This new method of stopping leaks we found to answer very well, as, in the course of a few days, when the mass had consolidated, the ship made very little water. By the 9th of June, the ship was again rigged with a jury mizen-mast, our cargo on board, and we were again ready for sea. On the 12th, we bid adieu to our Indian friends, and left Port Roussillon with the intention of running down the coast, and (if we found the ship not to leak so much as to be unsafe, to run for the Sandwich Islands, where I determined to leave her, and to take passage in some north-west fur trader for Canton.

FIGURE 15. EIN TANZ DER INDIANER IN DER MISSION VON ST. JOSÉ IN NEU-CALIFORNIEN. [Dance of the Indians at Mission San Jose, California.] *Photo by courtesy of Bancroft Library, University of California.*

G. H. VON LANGSDORFF

On the Uses Made of Clay at Mission San Jose

1806 *

[English translation is on page 169.]

Die ganze Lage des Ortes ist ausserordenlich glücklich gewählt, und nach der allgemeinen Meinung wird diese Mission in einigen Jahren eine der reichsten und besten von Neu-Californien seyn.

Der einzige Nachtheil ist, dass es hier an hochstämmigen Waldungen gänzlich mangelt. . . . .

Bey diesem Mangel hat aber diese Mission auch sehr beträchtliche Vorzüge vor vielen andern, indem sie in ihrer Nachbarschaft Kalkgebirge und vortressliche Thonerde hat, wodurch sie in den Stand gesetzt ist, Ziegelbrennereien anzulegen und alle Hauptgebäude von Backsteinen zu erbauen; . . . .

Padre Pedro, der mich allenthalben umher geführt hatte, schlug mir nach einigen Stunden vor, die Vorbereitungen der Indianer zum Tanz zu betrachten, und führte mich nach einem Bache, an dem sich die Tänzer versammelt hatten, und sich mit Kohlen, rother Thonerde und Kreide beschmierten; während der eine beschäftigt war, seine Brust, den Bauch und die Schenkel auf diese Art zu verschönern, so bemahlte ein anderer dessen Rücken mit verschiedenen regelmässigen Figuren. Einige bedeckten sich auch den ganzen, übrigens nackten, Körper mit Pflaumfedern, wodurch dann ein solcher Mensch eher das Ansehen eines Aussenähnlichen Thieres, als das eines Menschen hatte. Der Kopf, der Hals und die Ohren waren mit Zierrathen verschiedener Art geschmückt, und der ganze Körper, eine Schaambedeckung ausgenommen, nackend. Die Weiber putzten sich unterdessen in ihren Hütten; sie sind alle, wie es Anständigkeit und Sittlichkeit mit sich bringt, gekleidet, bemahlen sich blos das Gesicht und den Hals, den sie auch mit Zierrathen aus Muscheln, Federn, Korallen u. s. w. nach ihrer Art zu verschönern suchen.

---

* From *Bemerkungen auf einer Reise um die Welt in den Jahren 1803 bis 1807 von G. H. von Langsdorff, Kaiserlich-Russischen Hofrath, Ritter des St. Annen-Ordens Zweiter Classe, Mitgleid Mehrerer Akademien und Gelehrten Gesellschaften. Mit siebenzen Kupfern. Zweiter Band. Frankfurt am Mayn, im Verlag bey Friedrich Wilmans, 1812.*

FIGURE 16. ANSICHT DES SPANISCHEN ETABLISSEMENTS IN ST. FRANCISCO. M. G. Eichler sc. [View of the Spanish settlement, San Francisco.] *Photo by courtesy of Bancroft Library, University of California.*

FIGURE 17. JEU DES HABITANS DE CALIFORNIE. par Norblin d'après Choris. Lith. de Langlumé, r de l'abbaye N. 4. IV. [Game of the inhabitants of California.] *Photo by courtesy of Bancroft Library, University of California.*

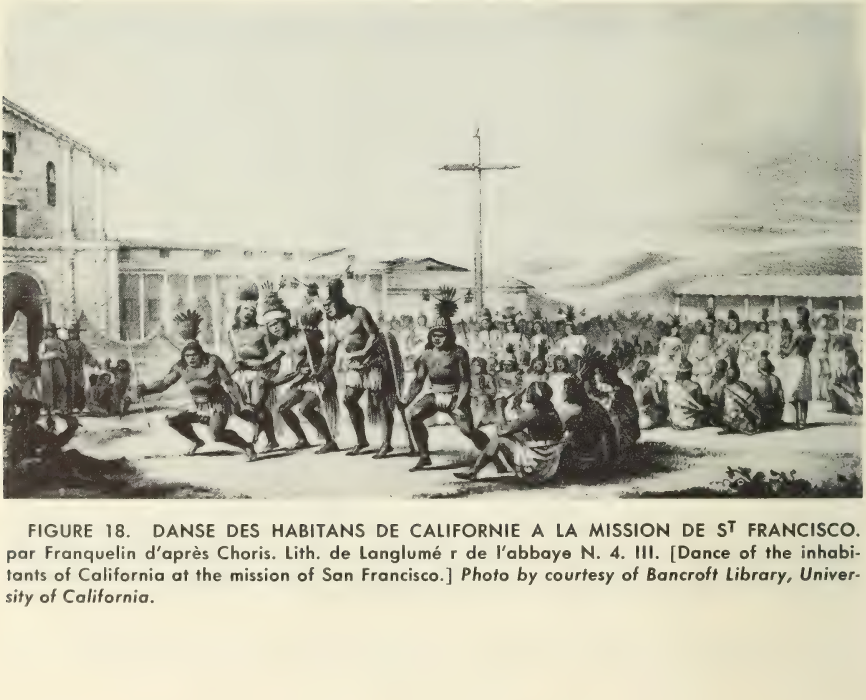


FIGURE 18. DANSE DES HABITANS DE CALIFORNIE A LA MISSION DE S^T FRANCISCO. par Franquelin d'après Choris. Lith. de Langlumé r de l'abbaye N. 4. III. [Dance of the inhabitants of California at the mission of San Francisco.] *Photo by courtesy of Bancroft Library, University of California.*

VISITORS FROM THE *RURICK*

On the Use of Adobe and Stone at San Francisco

October 1816 *

[English translation is on page 170.]

Den 3ten October. . . . . Heute machte ich nach Tische in Begleitung aller unserer Herren, einen Spaziergang ins Präsidio [San Francisco], wo der Commandant Don Louis d'Arguello uns am Thor empfing, mit acht Kanonenschüssen begrüsste und uns hierauf in seine Wohnung führte. Ich fand das Präsidio wie es Vancouver beschrieben; die Besatzung besteht aus einer Compagnie Kavallerie, wovon der Commandant Chef ist, und nur Einen Officier von der Artillerie unter seinem Commando hat.

Den 4ten. Um acht Uhr Morgens fuhren wir sämmtlich ans Land, und gingen in das Präsidio, um unserer Verabredung gemäss, in Gesellschaft des Commandanten, in die Mission zu reiten. . . . . Wir legten bei ausserordentlich schönem Wetter den Weg in einer Stunde zurück, obgleich er über die Hälfte aus Sand und Bergen bestand. Selten schmückten kleine Gesträuche die unfruchtbaren Hügel, und nur erst in der Nähe der Mission kamen wir in reizende Gegenden, und erkannten die üppige Natur Californiens. Nachdem wir durch eine von Indianern ** bewohnte Strasse geritten, hielten wir vor einem grossen, neben der Kirche liegenden Gebäude, das von den Missionairs bewohnt wird, und hier kamen uns fünf Geistliche entgegen, von denen drei zur hiesigen Mission gehörig, und zwei aus St. Clara zur Feier des Festes hergekommen waren; diese führten uns in ein grosses, einfach möblirtes, schmutziges Zimmer, wo mir mit Achtung empfangen wurden. Mit dem Schlage zehn traten wir in die geräumige, von Stein erbaute und im Innern hübsch verzierte Kirche, wo wir schon einige hundert halb nackte Indianer auf den Knieen liegend fanden. . . . . Aus der Kirche gingen wir zu Tische, wo es an Speisen und Wein, welchen letztern die Missionairs selbst verfertigen, nicht fehlte. Nach dem Essen zeigte man uns die Wohnungen der Wilden, welche aus langen und niedrigen, aus Lehmstein gebauten Häusern bestehen, und mehrere Strasse bilden. Die Unreinlichkeit in diesen Kasernen war unbeschreiblich, und diese mag der Grund der grossen

---

* The Russian brig *Rurick*, on a voyage whose stated purpose was the scientific exploration of parts of the South Sea, and the search for a northeast passage through Bering Strait into the Arctic Sea and Atlantic Ocean, put in at San Francisco from October 2 to November 1, 1816. Aboard her were Otto von Kotzebue, captain, and Adelbert von Chamisso, from whose reports of the expedition excerpts are reprinted herein. The three illustrations are by Louis Choris, artist of the expedition, and are reproduced from his book *Voyage Pittoresque Autour du Monde, Avec des Portraits de Sauvages d'Amerique, d'Asie, d'Afrique, et des Iles du Grand Ocean; des Paysages, des Vues Maritimes, et Plusieurs Objets d'Histoire Naturelle; Accompagné de Descriptions par M. le Baron Cuvier, et M. A. de Chamisso, et d'Observations sur les Crânes Humaines par M. le Docteur Gall. Par M. Louis Choris, Peintre. Paris, de l'Imprimerie de Firmin Didot, Imprimeur du Roi, de l'Institut et de la Marine, Rue Jacob, No 24. 1822.*

** Die Spanier nennen hier die Wilden: *los Indios*, wesshalb ich diese Benennung beibehalten habe.

OTTO VON KOTZEBUE †

† From *Entdeckungs=Reise in die Süd=See und nach der Berings=Strasse zur Erforschung einer nordöstlichen Durchfahrt. Unternommen in den Jahren 1815, 1816, 1817 und 1818, auf Kosten Sr. Erlaucht des Herrn Reichs=Kanzlers Grafen Rumanzoff auf dem Schiffe Rurick unter dem Besehle des Lieutenants der Russisch=Kaiserlichen Marine Otto von Kotzebue. Erster Band, mit zwei Kupfern und zwei Landkarten. Zweiter Band, mit fünf Kupfern und drei Landkarten. Dritter Band, mit dreizehn Kupfern und einer Landkarte. Enthält die Bemerkungen und Ansichten von dem Naturforscher der Expedition, Adelbert v. Chamisso, nebst Beiträgen von andern Gelehrten. Weimar, Verlegt von den Gebrüdern Hoffmann, 1821.*

Sterblichkeit seyn; denn von 1000 Indianern, welche sich in St. Francisco befinden, sterben jährlich 300. Die indianischen Mädchen, deren sich in der Mission 400 befinden, wohnen abgesondert von den Männern, ebenfalls in solchen Kasernen; beide Theile müssen schwer arbeiten.

Wir berufen uns im Uebrigen auf die Berichte von Laperouse und Vancouver, die wir treu erfunden haben. Seit ihrer Zeit hat sich nur weniges in Californien verändert.* Das Presidio ist neu aus Luftsteinen erbaut und mit Ziegeln gedeckt. Der Bau der Kapelle noch nicht angefangen, in den Missionen ist gleichfalls gebaut worden, und die Kasernen der Indianer zu S. Francisco sind von gleicher Bauart. Ein Artillerist hat Mühlen, die von Pferden getrieben werden, in den Missionen angelegt; sie sind jetzt meist ausser Stand und können nicht wieder eingerichtet werden. Zu S. Francisco ist noch ein Stein, den ohne Mechanik ein Pferd über einen andern Stein drehet, die einzige Mühle im Gange. Für eiliges Bedürfniss zerreiben die Indianer Weiber das Korn zwischen zwei Steinen. Eine Windmühle der Russisch-Amerikanischen Ansiedelung erregt Bewunderung und findet keine Nachahmung. Als von etlichen Jahren Handwerker mit grossen Unkosten hierher gezogen wurden, die verschiedenen Künste, deren man bedarf, zu lehren, benutzten die Indianer den Unterricht besser, als die *Gente racional* (das vernüftige Volk), Ausdruck, womit sich die Spanier bezeichnen; sie selbst sprachen ihnen das Zeugniss.

* Ein Fort, an gutgewählter Stelle angelegt, sperrt nun den Hafen von S. Francisco.

ADELBERT VON CHAMISSO †

† From *Bemerkungen und Ansichten auf einer Entdeckungs=Reise unternommen in den Jahren 1815-1818 auf Kosten Sr. Erlauch des Herrn Reichs=Kanzlers Grafen Romanzoff auf dem Schiffe Rurick unter dem Beschle des Lieutenants der Russisch=Kaiserlichen Marine Otto von Kotzebue von dem Naturforscher der Expedition Adelbert v. Chamisso. Der Philosophie Doctor, der Kaiserlich Leopoldinischen Akademie der Naturforscher, wie auch der Gesell=schaften der Naturforscher zu Berlin, zu Moskau, zu Leipzig, u.s.w. Mitgleid. Weimar, verlegt von den Gebrüdern Hoffmann. 1821.* (This is Book III of Kotzebue's *Entdeckungs=Reise.*)

FIGURE 19. VUE DU PRESIDIO S^N FRANCISCO. Lith. de Langlumé, r de l'Abbaye N 4. Lith. par V. Adam d'après Choris. II. [View of the presidio of San Francisco.] *Photo by courtesy of Bancroft Library, University of California.*

CAPTAIN FREDERICK WILLIAM BEECHEY

On Construction at the Missions

1826 *

The governor's abode was in the corner of the presidio [San Francisco], and formed one end of a row, of which the other was occupied by a chapel; the opposite side was broken down, and little better than a heap of rubbish and bones, on which jackals, dogs, and vultures were constantly preying, the other two sides of the quadrangle contained storehouses, artificers' shops, and the gaol, all built in the humblest style with badly burnt bricks, and roofed with tiles. The chapel and the governor's house were distinguished by being whitewashed. . . . .

The missions have hitherto been of the highest importance to California, and the government cannot be too careful to promote their welfare, as the prosperity of the country in a great measure is dependent upon them, and must continue to be so until settlers from the mother country can be induced to resort thither. . . . .

Each mission has fifteen square miles of ground allotted to it. The buildings are variously laid out, and adapted in size to the number of Indians which they contain; some are enclosed by a high wall, as at Sán Carlos, while others consist merely of a few rows of huts, built with sun-burnt mud-bricks; many are whitewashed and tiled, and have a neat and comfortable appearance. It is not, however, every hut that has a white face to exhibit, as that in a great measure

* From *Narrative of a Voyage to the Pacific and Beering's Strait, to Cooperate with the Polar Expeditions: Performed in His Majesty's Ship Blossom, Under the Command of Captain F. W. Beechey, R.N., F.R.S., &c. in the Years 1825, 26, 27, and 28. Published by Authority of the Lords Commissioners of the Admiralty. A New Edition. In Two Volumes. London: Henry Colburn and Richard Bently, New Burlington Street. 1831.* The illustrations that accompany these excerpts from Captain Beechey's report are from water-color sketches by William Smyth, who accompanied Beechey on his voyage to the Pacific. They have been published as lithographs in *California: A History of Upper and Lower California from Their First Description to the Present Time, Comprising an Account of the Climate, Soil, Natural Productions, Agriculture, Commerce &c. A Full View of the Missionary Establishments and Condition of the Free and Domesticated Indians With an Appendix Relating to Steam Navigation in the Pacific. Illustrated With a New Map, Plans of the Harbours, and Numerous Engravings. By Alexander Forbes, Esq. London: Smith, Elder and Co. Cornhill. 1839.*

"Beechey . . . . . sailed from England in May 1825, despatched to Bering Strait, there to await the arrival of Franklin and Parry of the arctic expeditions. Sailing by Cape Horn, Valparaiso, and the Hawaiian Islands, he arrived in Kotzebue Sound in July 1826, remaining in the far north until October, when he was obliged by the closing-in of winter and by want of supplies to sail for the south. He anchored at San Francisco November 6th, and was hospitably received by Comandante Martinez and Padre Tomás Esténega. Supplies were, however, less plentiful than had been expected, and a party . . . . . was sent overland to Monterey. This party was absent from the 9th to the 17th, during which time and subsequently Beechey and his men were occupied in making a survey of San Francisco Bay and scientific observations about its shores. No obstacles were thrown in his way, the authorities asking only for a copy of the resulting chart, which was given. The Englishmen amused themselves chiefly by excursions on horseback over the peninsula, and especially from the presidio to the mission, the inhabitants gaining an extraordinary revenue from the hire and sale of horses. The navigators also visited Mission San José late in November. . . . . The Englishmen sailed on December 28th for Monterey. Here they remained five days, cutting spars, and obtaining supplies from missions and from vessels in port . . . . . and on the 5th of January the *Blossom* sailed for the Sandwich Islands. After another trip to the Arctic, unsuccessful like the first, so far as meeting the ill-fated Franklin was concerned, Beechey returned to Monterey October 29, 1827, remaining until December 17th, when he went again to San Francisco for water, finally sailing on January 3d for San Blas, and thence home via Cape Horn and Brazil, reaching England in October 1828." *H. H. Bancroft, History of California, vol. 3, 1825-1840, pp. 120-122, 1886.*

FIGURE 20. THE MISSION OF SAN FRANCISCO, UPPER CALIFORNIA. Pub^{d} by Smith, Elder & C^{o} Cornhill. Capt. W. Smyth R.N. del. Day & Haghe Lith^{rs} to the Queen. *Photo by courtesy of California Historical Society.*

FIGURE 21. MISSION OF SAN CARLOS, AND BAY OF CARMEL, UPPER CALIFORNIA. Smith Elder & C^{o} Cornhill. Drawn by Capt^{n} W^{m} Smyth R.N. Day & Haghe Lith^{rs} to the Queen. *Photo by courtesy of California Historical Society.*

FIGURE 22. THE PRESIDIO AND PUEBLO OF MONTERREY, UPPER CALIFORNIA. Smith Elder & C° Cornhill. Drawn by Capt. Smyth, R.N. Day & Haghe Lith[rs] to the Queen. *Photo by courtesy of California Historical Society.*

depends upon the industry and good conduct of the family who possess it, who are in such a case supplied with lime for the purpose. It is only the married persons and the officers of the establishment who are allowed these huts, the bachelors and spinsters having large places of their own, where they are separately incarcerated every night.

To each mission is attached a well-built church, better decorated in the interior than the external appearance would lead a stranger to suppose. . . . . Each establishment is under the management of two priests if possible, who in Upper California belong to the mendicant order of Sán Francisco. They have under them a major-domo, and several subordinate officers, generally Spaniards, whose principal business is to overlook the labour of the Indians.

FIGURE 23. VUE DE LA MISSION DE SAN-LUIS-REY EN CALIFORNIE: A. Duhaut-cilly, del. Lith. Lorette et C[ie] S[t] Sorvan. H. Lorette Lith. *Photo by courtesy of Bancroft Library, University of California.*

A. DUHAUT-CILLY

On the Difficulties of Building at Santa Barbara Mission

March-April 1827 *

[English translation is on pages 171 to 179.]

Le 28 [Mars, 1827], nous eûmes en même tems connaissance des îles qui forment le canal, dit de Santa-Barbara et de la pointe Concepcion. Cette points après laquelle la côte prend une direction Est, est fort remarquable par sa forme. Sous l'aspect d'un coin de mire, elle s'élève de la mer; et s'abaissant ensuite vers l'intérieur, après avoir tracé une longue queue, elle remonte doucement jusqu' au sommet des montagnes.

Aussitôt que nous eûmes passé ce cap, la mer qui auparavant était fort agitée, devint droite et unie; mais la brise était faible, et nous n'avancions que lentement, ayant à notre droite les îles de San-Miguel, Santa-Rosa, et Santa-Cruz.

La côte que nous prolongions à deux milles de distance, est dominée par une chaîne de montagnes parallèles au rivage, de six à sept cents mètres d'élévation. A leur base s'étend une plaine terminée par des falaises verticales, qui laissent entre elles et la mer une plage étroite, de sable ou de galet. Cette campagne, où paissent de grands troupeaux de chevaux et de bêtes-à-cornes, est agréablement coupée à des distances presque égales par des vallées étroites. Dans ces ravins, croissent des massifs de beaux chêne, dont les cimes pressées et touffues semblent remettre de niveau tout ce terrain: des ruisseaux coulent dan ces vallons et servent à abreuver le bétail qui se nourrit aux environs. . . . .

Pendant que nous longeâmes ce rivage, nous trouvâmes la mer presque partout couverte de bitume, tantôt sous la forme de plaques arrondies, d'une certaine épaisseur, tantôt sous celle de larges nappes d'huile et de goudron, étendues sur l'eau et montrant des reflets jaunes ou azurés. L'odeur qu'exhalait cette matière, était assez forte pour incommoder, et rendre la respiration âpre et difficile. J'ai ignoré quelque tems si ce brai naturel, répandu en si grande quantité sur tout le canal, coulait de quelque point de la côte, ou si la source en jaillissait du fond de la mer; ce ne fut qu'a une autre relâche a Santa-Barbara, que je sus, qu'a moitié distance de ce Présidio, à la pointe Concepcion, entre le Rancho de Los-Ortegas et celui de Los-dos-Pueblos, se trouve un grand bassin de bitume qui bouillonne sans cesse, et dont le trop-plein dèborde dans la mer dont cette source n'est pas èloignée. . . . .

Nous allâmes ensuite à pied à la Mission, située à l'extrémité supérieure de la plaine, à une demi-lieue du Présidio. Le chemin qui y conduit monte d'une manière peu sensible, en traversant une belle pelouse, ou paissant les chevaux en service et les vaches qui fournissent le lait journalier au Présidio. A mesure que nous avancions, les bâtiments de la Mission se présentaient sous un plus bel aspect. De la rade, nous aurions pu la prendre pour un château du Moyen-Age, avec ses hautes ouvertures et son beffroi; en approchant, l'édifice s'agrandit, et sans rien perdre de sa beauté, il prend peu à peu un air religieux; la tourelle devient un clocher; l'airain, au lieu d'annoncer l'arrivée d'un chevalier, sonne l'Office ou l'Angelus; la première illusion est détruite, et le castel est un couvent.

---

* From *Voyage autour du monde, principalement à la Californie et aux Iles Sandwich, pendant les années 1826, 1827, 1828, et 1829; par A. Duhaut-Cilly, Capitaine au Long-Cours, Chevalier de la Légion d'Honneur, Membre de l'Académie d'Industrie Manufacturière, Agricole et Commerciale de Paris. Tome Premier, 1834. Tome Second, 1835. Paris, Chez Arthus Bertrand, Libraire, rue Hautefeuille, 23; Saint-Servan, Chez D. Lemarchand, Libraire.*

Sur le devant de la maison, au milieu d'une vast place, est une fontaine jaillissante, dont l'exécution, toute imparfaite qu'elle fût, nous causa une surprise d'autant plus grande, que nous nous attendions moins à rencontrer dans ce pays, d'ailleurs si éloigné des recherches européennes, cette espèce de luxe réservé chez nous aux demeures les plus opulentes. Aprés s'être élevée à plus de huit pieds au-dessus du sol, l'eau claire et brillante de cette fontaine retombait en larges nappes sur une suite décroissante de plateaux en pierre formant l'ensemble d'une pyramide octogone: elle remplissait jusqu'au bord un bassin de la même forme, d'où, sortant par la gueule d'un ours aussi en pierre, elle tombait dans un beau lavoir en stuc, autour duquel des Indiennes et de jeunes Californiennes étaient occupées à laver. Ces dernières nous regardèrent en dessous, à travers les belles tresses de leurs cheveux châtains, et je présume que l'examen qu'elles firent des deux étrangers fut aussi complet qu'il fut rapide.

Le beau sexe de tous le pays est seul en possession de cet advantage, d'apprécier un individu, et surtout de saisir ses ridicules, au moyen d'un regard furtif, et dans un clind'oeil. Je vis l'une de ces jeunes filles sourire d'une monière presque imperceptible: peut-être excitais-je moi-même sa malicieuse gaité; cependant la tournure assez grotesque de mon compagnon, ses dents calcinées par l'usage immodéré du tabac, et sa tête de singe, placée sur un corps grêle de quatre pieds huit pouces, tout cet ensemble dut un peu tranquilliser mon amour-propre.

Nous montâmes un perron de quelques degrés, qui nous conduisit sous un long péristyle ou cloître, soutenu par quinze piliers carrés formant quatorze arcades qui, de loin, donnent à la Mission cette apparence de noblesse qui nous frappa à la première vue. . . . .

. . . . . Fray Antonio Ripol, homme de bonne mine et d'un esprit distingué, me fit une partie des questions que m'avait déjà adressées son vieux compagnon; et lorsque j'eus satisfait sa curiosité ou plutôt sa sollicitude, il nous offrit de visiter les bâtiments de la Mission et l'église.

La facade de cette chapelle est ornée de six demi-colonnes soutenant un fronton triangulaire, chargé du plusieurs statues de saints. Le vase de l'église n'est composé que d'une nef à voûte plate, sans bas-côtés. La structure de cet édifice n'aurait donc rien qui dût exciter la surprise, s'il eût été bâti par des Européens; mais lorsque l'on considère qu'il est l'ouvrage de pauvres Indiens, guidés par un ecclésiastique; qu'il est éléve dans un pays qui, s'il renferme tous les matériaux nécessaires, ne les fournit du moins à la main que les emploie, que dans l'état sauvage où les produit la nature; on ne peut se lasser d'admirer la patience de ce religieux, le talent qu'il a déployé, et les soins qu'il a dû se donner une semblable construction.

Chez nous, veut-on entreprendre l'édification d'un bâtiment de ce genre? Dix architectes pour un se présentent avec leurs plans et leurs devis. On n'a qu'à choisir celui qui convient le mieux; on contracte des marchés avec des fournisseurs; tous les matériaux prêts à placer sont apportés sur le terrain désigné, sans qu'on ait à s'occuper d'autre chose qu'à vérifier leur qualité et à leur donner la dernière main; enfin, les meilleurs ouvriers se disputent la préférence sur leurs concurrents.

Ici, au contraire, tout est brut, jusqu'aux hommes, et le premier soin du constructeur a été de former ses ouvriers. Il a fallu, avec de la terre primitive, faire des briques et de la tuile; couper au loin des arbres immenses, et les apporter, à force de bras, par des chemins tracés exprès à travers les ravins et les précipices; recueillir à grands frais, sur le bord de la mer, les coquillages

pour les transformer en chaux; enfin, jusqu'au moindre élément de cet édifice a coûté des travaux préliminaires, qui ont dû augmenter considérablement les difficultés. On est en même tems étonné de la hardiesse du project et de la constance dans l'exécution: il n'y a qu'un zéle sans bornes pour l'extension de la religion, qui ait pu rendre le Padre Ripol victorieux de tant d'obstacles. Il n'a pourtant pas employé beaucoup plus de tems pour terminer le bâtiment qu'il n'en eût fallu en Espagne. . . . .

La nef, l'autel et la sacristie, sont décorés de peintures dont les meilleures sont venues du Mexique; les autres sont de la main des Indiens eux-mêmes. Les piliers, les frises, les encadrements et les plinthes sont marbrés avec assez de goût, et ornés d'arabesques passablement exécutés. Ce qui relève encore tout cet ensemble, et dispose à l'indulgence à l'égard des défauts d'architecture, c'est une propreté excessive, qu'on ne rencontre pas dans nos églises du troisième et même du second ordre.

Le projet qui l'occupait alors tout entier était un moulin à eau qu'il faisait établir au bas d'une colline, à la droite de la Mission. L'eau, amenée de plus de deux lieues, par un canal, suivant le flanc des montagnes, devait ce précipiter d'une hauteur d'environ vingt pieds, sur les augets de la roue. La chute de ce moteur n'était pas perpendiculaire; ells s'opérait sous un angle d'environ 35°; aussi, la roue, au lieu d'être verticale, était horizontale: c'était un plein-cercle, sur le plan duquel étaient disposées, comme des rayons, des espèces de grandes cuillers un peu concaves, qui devaient recevoir successivement l'impulsion et transmettre le mouvement.

Au premier aspect, je fus surpris que le Padre, homme de judgment, eût préféré l'inclinaison de la chute, quand il lui était si facile, en escarpant la colline, d'en obtenir une beaucoup plus puissante; car, sans être hydrostaticien, je m'apercevais bien que son moteur perdrait d'autant plus de sa force, que son inclinaison serait plus éloignée de la verticale. Cependant, avant d'avoir manifesté mon opinion, la réflexion me ramena à l'avis de l'inventeur, et je crus reconnaître que ce qu'il perdait d'abord de puissance motrice, il le gagnait d'un autre côte, en évitant le frottement de deux engrenages, puisque la meule tournante serait établie sur l'arbre même de la roue.

Une autre objection peut encore être faite, à l'égard de la vitesse de rotation; car, dans ce système, elle est égale pour la roue et pour la meule, tandis que, dans notre combinaison ordinaire, la vitesse de la meule augmente, dans le rapport du rayon de la roue, au rayon de la lanterne de l'arbre. Au reste, les ouvriers de Fray Antonio étant peu versés dans la mécanique, il évitait beaucoup d'imperfection, en simplifiant la machine, et je ne doutai pas de la pliene réussite de son entreprise. Je lui fis toutefois remarquer que la qualité de la pierre qu'il employait pour ses meules d'une seule pièce, n'était pas convenable; parce qu'étant toute composée de parties presque homogènes et d'une égale dureté, elle se polirait trop promptement. Après le diné, le Président fut dormir sa siesta, et nous retournâmes à bord.

ALFRED ROBINSON

On California Building and Building Materials

1829-45 *

The next day [February 16, 1829], when I was to look for the first time upon those shores which were to become for some years my home, was necessarily one of great excitement, and I hurried on deck much earlier than my usual hour. Before us lay stretched out the shore, and as it curved away toward the northern extremity of [Monterey] bay, the swell of the ocean, wave after wave, echoed loud and heavily upon its sands. The sun had just risen, and glittering through the lofty pines that crowned the summit of the eastern hills, threw its light upon the lawn beneath. On our left was the "Presidio," with its chapel dome, and towering flag-staff in conspicuous elevation. On the right, upon a rising ground, was seen the "Castillo," or fort, surmounted by some ten or a dozen cannons. The intervening space between these two points was enlivened by the hundred scattered dwellings that form the town; and here and there groups of cattle grazing.

After breakfast, G. and myself went on shore on a visit to the Commandant, D. Mariano Estrada, whose residence stood in the central part of the town, in the usual route from the beach to the Presidio. Its external appearance, notwithstanding it was built of *adobe* or brick, made by the mixture of soft mud and straw, modelled and dried in the sun, was not displeasing; for the outer walls had been plastered and whitewashed, giving it a cheerful and inviting aspect. Like all dwellings built in the warm countries of America, it was but one story in height, covered with tiles, and occupied, in its entire premises, an extensive square. . . . .

. . . . . Mission [San Luis Rey] was founded in the year 1798, by its present minister, father Antonio Peyri, who had been for many years a reformer and director among the Indians. At this time (1829) its population was about three thousand Indians, who were all employed in various occupations. . . . .

The building occupies a large square, of at least eighty or ninety yards each side; forming an extensive area, in the centre of which a fountain constantly supplies the establishment with pure water. The front is protected by a long corridor, supported by thirty-two arches, ornamented with latticed railings, which, together with the fine appearance of the church on the right, presents an attractive view to the traveller; the interior is divided into apartments for the missionary and mayordomos, store-rooms, workshops, hospitals, rooms for unmarried males and females, while near at hand is a range of buildings tenanted by the families of the superintendents. There is also a guard-house, where were stationed some ten or a dozen soldiers, and in the rear spacious granaries stored with an abundance of wheat, corn, beans, peas, &c.; also large enclosures for wagons, carts, and the implements of agriculture. In the interior of the square might be seen the various trades at work, presenting a scene not dissimilar to some of the working departments of our state prisons. Adjoining are two large gardens, which supply the table with fruit and vegetables, and two or

* From *Life in California: During a Residence of Several Years in That Territory, Comprising a Description of the Country and the Missionary Establishments, With Incidents, Observations, Etc., Etc. Illustrated With Numerous Engravings. By An American. To Which is Annexed a Historical Account of the Origin, Customs, and Traditions, of the Indians of Alta-California. Translated from the Original Spanish Manuscript* [of the Reverend Father Friar Geronimo Boscana]. *New York: Published by Wiley & Putnam, No. 161 Broadway. 1846.*

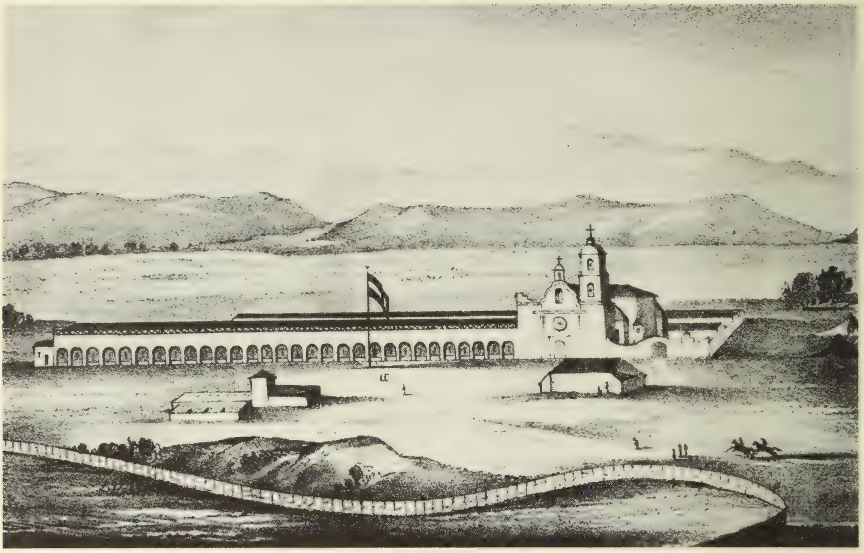


FIGURE 24. VIEW OF THE MISSION OF ST LUIS REY. A Robinson Del. Lith of G. & W. Endicott. *Photo by courtesy of California State Library.*

three large "*ranchos*" or farms are situated from five to eight leagues distant, where the Indians are employed in cultivation and domesticating cattle.

The church is a large, stone edifice, whose exterior is not without some considerable ornament and tasteful finish; but the interior is richer, and the walls are adorned with a variety of pictures of saints and Scripture subjects, glaringly colored, and attractive to the eye. Around the altar are many images of the saints, and the tall and massive candelabras, lighted during mass, throw an imposing light upon the whole. . . . .

. . . . . [Mission San Juan Capistrano] was founded in the year 1776, and, though in early years the largest in the country, yet is now in a dilapidated state, and the Indians much neglected. There yet remain the ruins of an immense church, which was destroyed by an earthquake in 1812, when many Indians were buried in its fall. It still bears the appearance of having been one of the best finished structures of the country, and the workmanship displayed in the sculpture upon its walls and its vaulted roof would command admiration in our own country.

The arrangement of the mission of St. Juan is similar to that of St. Luis; in fact, all these establishments are formed upon the same plan, and much resemble each other, varying only in their extent and population. In many of the villages the residences consist of straw huts of an oval form, which, when decayed, the Indians set on fire and erect new ones—here, however, they are built of unburnt brick, tiled and whitewashed, forming five or six blocks, or streets, which present a neat and comfortable appearance. . . . .

St. Fernando was founded in the year 1797, and at this time was governed by the reverend father Francisco Ybarra. . . . . Distrustful of every one who wished to purchase his tallow or hides, he had accumulated an immense amount in his storehouses, where many of the latter had been destroyed by the length of time they had remained deposited. The tallow he had laid down in large, arched, stone vats, of sufficient capacity to contain several cargoes. . . . .

FIGURE 25. VIEW OF THE MISSION OF S^{T} GABRIEL. A Robinson Del. Lith of G. & W. Endicott. *Photo by courtesy of California State Library.*

FIGURE 26. VIEW OF THE PRESIDIO OR TOWN OF SANTA BARBARA. A. Robinson Del. Lith. of G. & W. Endicott. *Photo by courtesy of California State Library.*

FIGURE 27. VIEW OF THE "PRESIDIO" OR TOWN OF SANTA BARBARA; TAKEN FROM A HILL NEAR THE FORT. A. Robinson Del Lith. of G. & W. Endicott. *Photo by courtesy of California State Library.*

FIGURE 28. A VIEW OF THE MISSION OF SANTA BARBARA. A. Robinson Del. Lith. of G. & W. Endicott. *Photo by courtesy of California State Library.*

. . . . . Seen from the ship, the "Presidio" or town [Santa Barbara], its charming vicinity, and neat little Mission in the background, all situated on an inclined plane, rising gradually from the sea to a range of verdant hills, three miles from the beach, was a striking and beautiful effect. Distance, however, in this case, "lends enchantment to the view," which a nearer approach somewhat dispels; for we found the houses of the town, of which there were some two hundred, in not very good condition. They are built in the Spanish mode, with *adobe* walls, and roofs of tile, and are scattered about outside of the military department; shewing a total disregard of order on the part of the authorities. A ridge of rugged highlands extends along the rear, reaching from St. Bonaventura to Point Conception, and on the left of the town, in an elevated position, stands the *Castillo* or fortress. . . . .

The Presidio of Santa Barbara consists of a large square of buildings, surrounded by high walls, in plan similar to that of St. Diego, and contains a chapel, cemetery, prison, and storehouses. . . . .

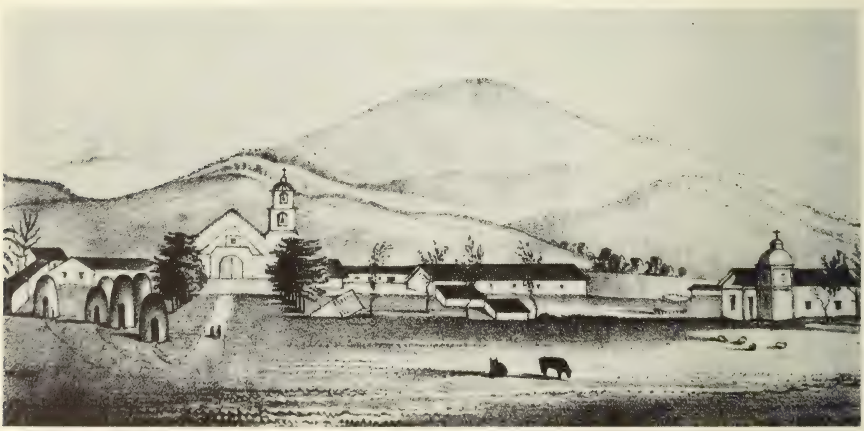


FIGURE 29. VIEW OF THE MISSION OF S^{T} BUENAVENTURA. A. Robinson Del. Lith of G. & W. Endicott. *Photo by courtesy of California State Library.*

FIGURE 30. VIEW OF THE PLACE OF ANCHORAGE AT "YERBA BUENA" IN S[T] FRANCISCO. F. Teschmaker Del. Lith. of G. & W. Endicott. "When morning came, I found we were in a small bay, close to the shore; on one side of which were steep rocks, and on the other a smooth sandy beach. Outside of this was the island of Yerba Buena, and beyond this, on the other side of the bay of St. Francisco, the highlands of St. Antonio." *Photo by courtesy of California State Library.*

In the morning we walked to the mission, distant from the town about half a league. The road was pleasant, through scattered oaks; and groups of cattle were seen grazing upon the grassy plains. On the right were spacious wheat fields; at length, through a narrow way, amid immense rocks scattered over the ground, we reached the establishment. The stone church, with its two towers and extensive wing, its artificial clock, tiled roofs, arched corridor, and majestic fountain, was before us. On the right were various buildings for superintendents, a guard-house, tannery, and a dilapidated grist-mill; on the left, the spacious garden, with its fruit trees and flowers, and several rows of low buildings. Father Antonio Jimeno, the missionary, received us in a small but tastefully arranged apartment; the floor of which was of colored cement, and the walls painted and hung round with pictures of saints. Two or three sofas, a long table and bookcase, comprised its furniture. He welcomed us kindly, and after a short conversation, we walked into the "*patio*," or square, where carpenters, saddlers, and shoe-makers were at work, and young girls spinning and preparing wool for the loom. We next entered the vestry, which was carpeted and hung round with looking-glasses and fine paintings. Adjoining this was a small but convenient dressing-room, where were arranged the numerous dresses and ornaments used in the church services, some of them rich and of the most costly description. From this, a door led into the church, where we beheld a gorgeous display of banners, paintings, images, and crucifixes of gold and silver. The musicians attached to the choir were practising, and played some very fine airs; rather unsuitable, however, to the place. It was not unusual, both there and at the churches of other missions, to hear during the mass the lively dancing tunes. Another door of the church opened upon the cemetery, where were buried the deceased Christians of the Mission and Presidio, surrounded by a thick wall, and having in one corner the charnel house, crowded with a ghastly array of skulls and bones.

In the rear, from a slight elevation, might be seen large fields of wheat and corn; and the little valleys among the hills, filled with fruit and vegetable gardens. A foaming stream rushes down the mountain, from which is carried in an open aqueduct along the brow of the hill, a supply of water for a spacious reservoir of beautiful masonry. . . . .

[Santa Ynes] Mission, founded in 1797, was governed by Father Blas Ordas, who received us with the accustomed cordiality of his hospitable order. The building we found much like that of Santa Barbara, differing only in the appearance of the church and the cleanliness of its apartments. In front was a large brick enclosure where the females bathed and washed; to the right the gardens, filled with choice fruit trees, and on the left a few clusters of Indian huts and tiled houses. . . . .

In the morning we rode over to the Purissima, where we found two reverend friars, Fathers Victoria and Juan Moreno. This mission was originally established in 1787, at a place now known as "La Mision Vieja;" but has since been rebuilt in its present location, and though possessing abundant wealth, in cattle and planting grounds, yet it has been much neglected, and the Indians generally are ill clothed, and seem in the most abject condition. We remained here but a short time, and returned to Santa Ynes, slept there that night, and the next day reached the ship.

The morning after, we set out on an excursion to St. Buenaventura. . . . . which was founded in 1782, and which is situated near the sea-shore, at the entrance of a valley leading into the interior among the mountains. . . . . Besides the church building, there is a small chapel towards the beach, in which mass is at no time performed except on extra-ordinary occasions. . . . .

. . . . . The Mission of St. José was founded in 1797. . . . .In the rear of the establishment, is a large reservoir of excellent water, which is carried through pipes, to the gardens, and other parts of the Mission. In front of the church is a very neat fountain, and also conveniences for washing and bathing. In point of beauty, the buildings here were very inferior to those of the southern missions. Durability and convenience alone, seem to have been consulted in their construction, and they mostly present a very ordinary appearance.

. . . . . At length . . . we alighted at the farm-house [near San Jose] of a Californian.

As we rode up to the entrance, a score of dogs came rushing out, as if to annihilate us, but a gentle reproof from the master, who appeared at the door, called them off, and we entered. This cottage was built of sticks, covered over with mud, and the roof with 'brea." . . . Dinner was prepared for us—horses were proffered to assist us on the journey, and, as usual among these hospitable people, no recompense was required. . . . .

DUFLOT DE MOFRAS

On Construction at the Missions and Presidios 1840-42 *

[English translation is on pages 180 to 189.]

En même temps que les moines établissaient des missions pour civiliser les Indiens, les gouverneurs fondaient des postes militaires nommés presidios, et des pueblos (villages) composés de soldats mariés et de colons blancs que l'on faisait venir de Sonora, de Sinaloa et de la Basse Caifornie. Comme ces trois genres d'établissements, missions, presidios et pueblos, sont tous formés sur le même plan, il suffira d'en décrire un pour donner une idée de tous les autres. Nous prendrons pour type la mission consacrée à saint Louis Roi de France, qui est la plus belle et celle dont l'architecture est la plus régulière. (Voir dans l'Atlas la perspective nº 23 et le plan géométrique nº 24 de la mission de Saint-Louis Roi de France.)

DESCRIPTION D'UNE MISSION

L'édefice est un quadrilatère de cent cinquante mètres de front; l'église occupe une des ailes; la façade est ornée d'une galerie. Le bâtiment, élevé d'un étage, est généralement exhaussé de quelques pieds au-dessus du sol. L'interieur est formé par une cour ornée de fontaines et plantée d'arbres. Sur la galerie environnante s'ouvrent les portes des logements des moines, des majordomes, des voyageurs, celles des ateliers, des écoles, des magasins. Les infirmeries pour hommes et pour femmes sont situées dans les parties les plus paisibles de la Mission, où se trouvent aussi les écoles. Des jeunes filles indiennes habitent des salles nommées le monastère (*el monjerìo*), et elles-mêmes sont appelées les nonnes (*las monjas*). Les moins sont obligés de les renfermer pour les mettre à l'abri de la brutalité des indigènes. . . . .

Pour encourager les Indiens au travail, les Pères mettaient souvent la main à l'oeuvre et donnaient partout l'exemple. Il y a quelques années à peine que le

* From *Exploration de Territoire de l'Orégon, des Californies et de la Mer Vermeille, Exécutée Pendant les Années 1840, 1841, et 1842, Par M. Duflot de Mofras, Attaché à la Légation de France à Mexico; Ouvrage Publié par Ordre du Roi, Sous les Auspices de M. le Marechal Soult, Duc de Dalmatie, Président du Conseil, et de M. le Ministre des Affaires Étrangères. Tome Premier, Tome Second. Paris, Arthus Bertrand, Editeur, Libraire de la Société de Géographie, Rue Hautefeuille, nº 23. 1844.*

"M. Eugène Duflot de Mofras was a young attaché of the French embassy at Madrid, who had previously visited America, when at the end of 1839 he was called by Marshal Soult, minister of foreign affairs, and attached to the legation at Mexico, with a special mission to visit the north-western provinces of the republic, and the American, English, and Russian posts beyond, 'in order to ascertain, independently of a political point of view, what advantage might be offered to our commerce and to our navigation by mercantile expeditions, and the establishment of trading-posts in those regions still little known in France'. . . . . In April 1841 he came up from Mazatlan with Captain Fitch on the *Ninfa*, touching first, perhaps, at San Pedro, and arriving at Monterey in May. Before June 11th he had visited Sonoma with a letter of introduction to Vallejo from Virmond, and probably went to Ross before returning to the capital. In July he was at Monterey, as appears from his letters. September 1st he arrived at Sutter's Fort; and during the same month was at San José and Santa Cruz. October 18th the traveller had embarked at San Francisco on the *Cowlitz* for Fort Vancouver . . . . . and on December 30th he came back on the same vessel to San Francisco. . . . . Mofras . . . . . immediately took passage on the Bolívar for Monterey; and on January 3d . . . . . sailed with Captain Pierce for Mazatlan on the *Maryland*, which touched at Santa Bárbara, and remained for nine days, January 18th to 27th, at San Diego. During the travels . . . . . Mofras visited probably every Mission and other settlement in California. I suppose that the Santa Bárbara district was explored in April, as the *Ninfa* came up the coast; those of Monterey and San Francisco from May to October, the explorer making his headquarters at the capital and Yerba Buena; and that of San Diego in January 1842, while the *Maryland* was disposing of her cargo." *H. H. Bancroft, History of California, vol. 4, 1840-1845, pp. 248-250, 1886.*

FIGURE 31. SKETCH OF MISSION OF SAN DIEGO DE ALCALA, MADE IN 1849 BY CAVE J. COUTS, LIEUTENANT, FIRST DRAGOONS. *Reproduced from a copy in Serra Museum, San Diego, by permission of San Diego Historical Society.*

FIGURE 32. SKETCH OF SAN LUIS REY MISSION, MADE IN 1849 BY CAVE J. COUTS, LIEUTENANT, FIRST DRAGOONS. *Reproduced from a copy in Serra Museum, San Diego, by permission of San Diego Historical Society.*

Père Cavallero, président des Dominicains, est mort la charrue à la main, au milieu de ses néophytes de la mission de Notre-Dame de Gaudalupe. Le nécessité les rendait industrieux; on est frappé d'étonnement en voyant qu'avec si peu de ressources, la plus souvent sans ouvriers européens, à l'aide de populations sauvages d'une intelligence presque nulle, et souvent hostiles, ils aient pu exécuter, indépendamment des travaux de grande culture, des ouvrages si considérables d'architecture de mécanique, tels que moulins, machines et métiers, des ponts, des routes, des canaux d'irrigation. Il a fallu, pour la construction de presque toutes ces missions, amener de huit et dix lieues sur le terrain choisi, des pièces de bois coupées souvent sur des montagnes escarpées, apprendre aux Indiens à faire la chaux, à tailler des pierres et à mouler des briques.

Autour de la mission, s'élèvent les bâtiments d'exploitation, les cabanes des néophytes et les maisons de quelques colons blancs. Outre l'établissement cen-

FIGURE 33. VUE DU PORT DE MONTEREY CAPITALE DE LA NOUVELLE CALIFORNIE. Publie par Arthus Bertrand. Ch. Ransonnette. Voyage de M. D. de Mofras. Vig. N° 1. *Photo by courtesy of California State Library.*

tral, il existe, sur une étendue de trente à quarante lieues carrées, des fermes accessoires au nombre de quinze à vingt, et quelques chapelles succursales. En face de la mission se trouve un corps de garde où longeait l'escorte des moines; cette escorte était composée de quatre soldats de cavalerie et d'une sergent; elle servait aussi à faire le service des dépêches, à transporter des ordres d'une mission à l'autre, et à repousser les incursions des tribus sauvages qui, dans les premiers temps de la conquête, venaient assaillir les établissements. . . . .

DESCRIPTION D'UN PRESIDIO

Les Presidios étaient tous établis sur un plan analogue. On choisissait un emplacement favorable et on l'entourait d'un fossé de quatre mètres de large sur deux de profondeur. La terre du déblai servait d'epaulement extérieur. L'enceinte du Presidio était formée par un quadrilatère de deux cents mètres de front environ. Le rempart ou muraille, construit en briques, avait quatre à cinq mètres de haut sur un d'épaisseur; de petits bastions flanquaient lesangles; le Presidio n'avait que deux portes. Son armement entier se composait généralement de huit pièces de canon en bronze, du calibre de huit, douze et seize. Incapables de résister à une attaque sérieuse faite par des navires de guerre, ces fortifications étaient suffisantes pour repousser les incursions des Indiens. Non loin des Presidios, et suivant la topographie du terrain, s'élevaient des batteries découvertes, pompeusement décorées du nom de *castillo* (château). Dans l'enceinte du Préside se trouvaient l'église, les logements des officiers et des soldats, les maisons de quelques colons, des magasins, des ateliers, des écuries, des puits et des citernes. En dehors, se groupaient quelques habitations, et à une petit distance on rencontrait le ferme du roi (*el rancho del rey*), destinée à fournir des pâturages aux chevaux et aux bêtes de somme de la garnison.

Quatre batteries de côte et quatre Presidios defendaient la Haute Californie: ceux de San Diego, de Monte Rey, de San Francisco et de Santa Bàrbara. . . . .

Un jour, étant allé le voir [Fr. Tomás Esténega, San Gabriel Mission], je trouvai dans un champ, devant une grande table, le capuchon renversé, les manches retroussées, pétrissant de l'argile et montrant à faire des briques aux

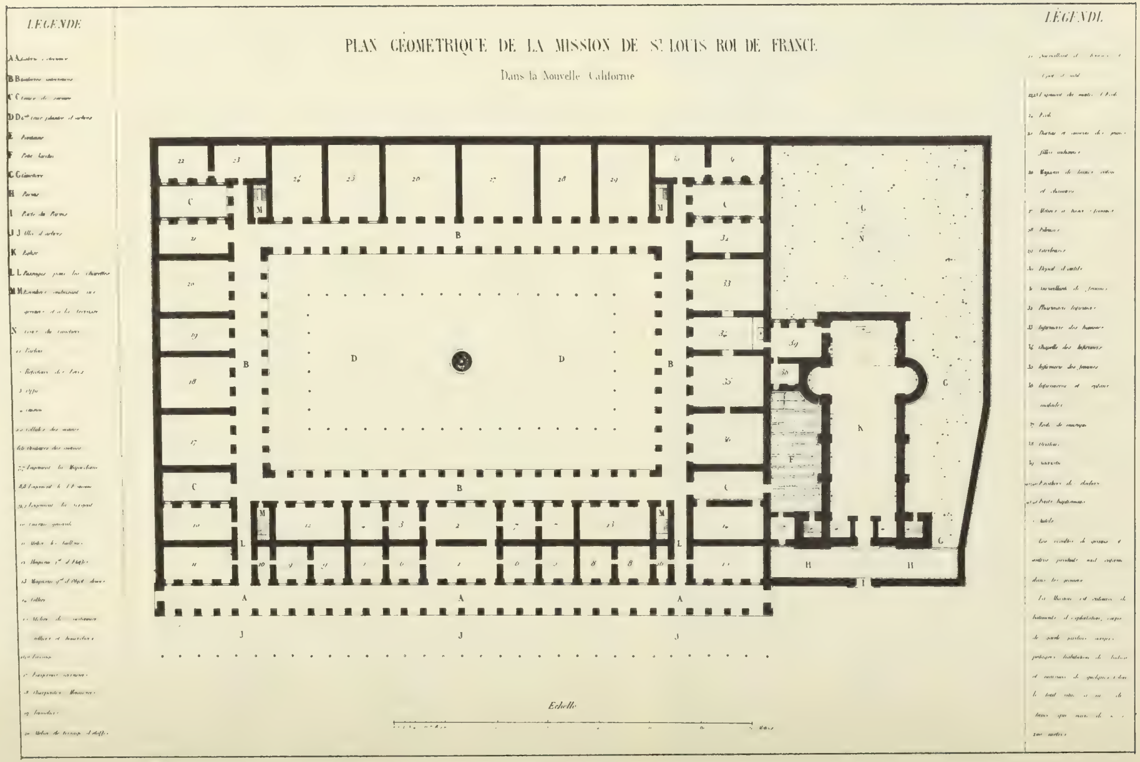


FIGURE 34. PLAN GÉOMÉTRIQUE DE LA MISSION DE SAINT LOUIS ROI DE FRANCE DANS LA NOUVELLE CALIFORNIE. Gravé sur pierre par Ch. Avril. Paris Arthus Bertrand, Editeur. Lith. de Binetean. Voyage de M[r] D. de Mofras. N[o] 24 de l'Atlas. *Photo by courtesy of California State Library.*

FIGURE 35. VUE DE LA MISSION DE SAINT LOUIS ROI DE FRANCE DANS LA NOUVELLE CALIFORNIE. Publié par Arthus-Bertrand. Imp. par Lemercier. Lith. par Muller. Voyage de M[r] D. de Mofras. N° 23 de l'Atlas. *Photo by courtesy of California State Library.*

FIGURE 36. LE R. P. NARCISO DURAN Préfet apostolique des Franciscains Espagnols missionnaires dans la Nouvelle Californie. Publié par Arthus Bertrand. Ch. Ransonnette sc. Voyage de M. D. de Mofras. Vig. N° 2. *Photo by courtesy of California State Library.*

FIGURE 37. RANCHERO CALIFORNIEN JETANT LE LAZO. Publié par Arthus Bertrand. Imp. de Bougeard. Ch. Ransonnette, sc. Voyage de M. D. de Mofras. Vig. N° 3. *Photo by courtesy of California State Library.*

néophytes qui l'entouraient. De plus loin qu'il m'aperçut il me salua de la main en me criant: "*Amigo! con esta familia,* CONSILIO MANUQUE!" . . . . .

Un de nos nationaux, M. Charles Baric, celui qui, par son intelligence et sa connaissance du pays, pourrait rendre le plus de services, trafique dans toute la province, mais depuis quelque temps il se livre à l'exploitation d'une mine d'or vierge en grains qu'il a découverte au rancho de San Francisquito, à six lieues dans la montagne, au nord de la Mission de San Fernando, et à quinze lieues de los Angeles. Ce filon a une étendue de seize lieues, suivant la direction du ravin où il est situé. L'or se trouve presque á la surface du sol, et quelques morceaux pèsent de duex à trois gros. On l'achète, dans le pays, à raison de quatorze piastres l'once, payables en espèces, ou seize piastres en marchandises. Au rancho de Cahuenga, à deux lieues au nord-ouest du Pueblo, il existe des minerais d'argent non exploités faute de mercure et de personnes connaissant l'industrie minière. Les Indiens rapportent souvent de la sierra des grains de cuivre natif, des fragments d'opale et des morceaux de galène (sulfure de plomb).

A deux lieues au sud-est, on trouve quatre grandes sources d'asphalte situées à fleur de terre, dans une vaste prairie. Ces bouches s'ouvrent au milieu de petits mares d'eau froide, tandis que le bitume possède une température supérieure. Cette eau a un goût minéral, qui n'empêche pourtant pas les bestiaux de s'en abreuver. Au lever du soleil, les orifices des sources sont couverts par d'enormes cloches d'asphalte, ayant souvent plus d'un mètre de haut, et semblables à des bulles de savon. A mesure que l'airs s'échauffe, les gaz contenus dans la cloche se dilatent, et cette dernière éclate en produisant une détonation assez violente. Les habitants recueillent l'asphalte solidifié, et s'en servent pour enduire les toits de leurs maisons, formés de roseaux ou de planchettes (bardeux). Les navires transportent aussi ce bitume sur divers points du départment. Cette matière presénte cependant l'inconvénient de se fondre au soleil, de couler en bas des

FIGURE 38. ANTONIO MENDOZA, THE MEXICAN GOLD WASHER IN CALIFORNIA, FIRST DISCOVERER OF THE LARGE GOLD TRACKT—TAKEN FROM LIFE, 1842. *Sketch by G. M. Waseurtz af Sandels, from the original in the collection of The Society of California Pioneers. Photo by Mary Rae Hill.*

toits et de s'infiltrer à travers la toiture. Les maisons qui en sont couvertes demandent un entretien attentif, mais peu coûteux, puisque les sources sont exploitées par chacun selon ses besoins. . . . .

Dans le canal de Santa Bàrbara le courant vient du nord et suit la direction de la côte; les sources d'asphalte qui se jettent dans la mer répandent à sa surface une couche huileuse et noirâtre qui s'aperçoit de loin et laisse échapper une odeur bitumineuse qui s'étend à plusieurs lieuses au large. . . . .

MISSION DE SANTA BARBARA

La Mission de *Santa Bárbara* (de Sainte-Barbe) . . . . . est située à une lieue de la mer et à deux kilomètres du Pueblo, au pied d'une chaîne de montagnes arides qui la protégent contre les vents de l'est et du nord. Sa construction est très-régulière; sa galerie, formée par des arcades, et l'église, qui a deux belles tours, sont bâties en pierre de taille. Les jardins et vergers sont très-vastes et bien arrosés; il y a sur la place de la Mission une grande fontaine dont les eaux sont amenées de la montagne et font mouvoir un beau moulin. On trouve dans la sierra les dépôts calcairs des coquilles que l'on emploie à la bâtisse. Cette Mission, resserrée entre le rivage et les montagnes, ne possède qu'un petit nombre de terrains propres à la culture; aussi n'a-t-elle jamais atteint un grand dével-oppement. . . . .

A une lieue et demie au nord de Santa Bárbara, on trouve sur la côte le rancho de la Brea, près duquel s'ouvrent dans la mer plusieurs bouches de goudron minéral. Sur le rivage et sur plusieurs autres points on recontre des croûtes de bitume. A sept lieues de la mer, à vingt-six de Los Angeles et a l'est du Pueblo

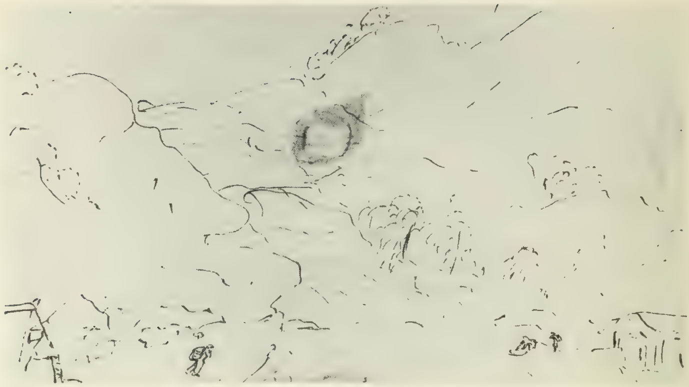


FIGURE 39. GOLD WASHING AT ST. FRASISQITO IN 1842 OR 3. *Sketch by G. M. Waseurtz af Sandels, from the original in the collection of The Society of California Pioneers. Photo by Mary Rae Hill.*

FIGURE 40. GOLD FISHING ON THE COAST OF CALIFORNIA BAY. *Sketch by G. M. Waseurtz af Sandels, from the original in the collection of The Society of California Pioneers. Photo by Mary Rae Hill.*

de Santa Bárbara, il existe au rancho de las Pozas un volcan dont le cratère peu élevé laisse de temps en temps échapper de la fumée. Les alentours de ce volcan sont remplis de soufre. A une lieue environ de la Mission, on voit aussi des sources d'eau sulfureuse dont la température est voisine de celle de l'eau bouillante. . . . .

L'establissement [Sutter's Fort] est situé à deux milles à l'est du fleuve, et à un mille au sud de la Fourche américaine. Du débarcadère aux bâtiments, on traverse une belle prairie ombragée de chênes énormes. On n'a pu construire de maisons sur le bord même du Rio Sacramento, à cause des inondations annuelles. Le fort de la Nouvelle Helvétie est adossé, au nord, à un petit ruisseau dont les bords escarpés concourent à la défense; l'enceinte est fermée par un mur de cinq pieds d'épaisseur, construit en briques cuites au soleil, et soutenu par de grandes pièces de bois: chaque face du quadrilatère présente un développement de cent mètres; les angles sont flanqués de bastions carrés, ayant deux étages; les quatre plans sont percés d'embrasures, et une galerie extérieure couronne toute la muraille.

T. J. FARNHAM

On Stone and Tile Work at Carmel and Santa Barbara Missions

1841 *

The mission buildings [San Carlos Borromeo, or Carmel] are situated on the north side of the valley near the sea. They stand on elevated ground, which overlooks the bay and seven or eight miles of the vale. They were inhabited by a family of half-breeds, who kept the keys of the church. The edifices were built around a square of half an acre. On the west, south, and east sides of it, are the Indian houses with their ruined walls, scalloped tile roofs, clay floors and open unglazed windows. On the north side are the church, the cells and dining hall of the Padres. The latter is about forty feet by twenty, lighted by open spaces in the outer wall, grated with handsomely turned wooden bars, and guarded by plank shutters, swinging inside. At the west end of this room is a small opening through which the food was passed, from the kitchen. On the north side and east end are four doors opening into the cells of the friars. . . . .

There was an outside stairway to the tower. . . . .The walls of the church are of stone masonry; the roof of brick tiles. The whole structure is somewhat lofty, and looks down upon the surrounding scenery, like an old baronial castle, from which the chase, the tournament, and the reign of beauty have departed. An oaken arm-chair, brown and marred with age, stood on the piazza, proclaiming to our lady of Guadaloupe and a group of saints rudely sketched upon the walls, that Carmelo was deserted by living men. . . . .

. . . . . Santa Barbara is situated on an inclined plane, which rises gradually from the sea side of a range of picturesque highlands three and a half miles from the sea. The town itself is three quarters of a mile from the landing. The houses are chiefly built in the Spanish mode, adobie walls, and roofs of tile. These tiles are made of clay, fashioned into half cylinders, and burned like brick. In using them, the first layer is placed hollow side up; the second inversely, so as to lock over the first. Their ends overlap each other as common shingles do. This roofing serves very well in dry weather. But when the driving southwesters of the winter season come on, it affords a poor shelter. Very few of the houses have glass windows. Open spaces in the walls, protected with bars of wood, and plank shutters, serve instead. Mr. A. B. Thompson, a wealthy and hospitable American merchant, has erected a residence in the centre of the town, which bears very striking testimony to his being a civilized man.

There is an old Catholic mission, one mile and three quarters above the town, called El Mission de Santa Barbara. The church itself is a stone edifice, with two towers on the end towards the town, and a high gable between them. The friars complimented Father Time, by painting on the latter something in the shape of a clock dial. In the towers are hung a number of rich toned bells, brought from old Spain nearly a hundred years ago. The residence of the Padres, also built of stone, forms a wing with the church towards the sea. The prisons form another, towards the highlands. Hard by are clusters of Indian huts, constructed of adobies and tile, standing in rows, with streets between.

* In *Life, Adventures, and Travels in California. By T. J. Farnham. To Which Are Added the Conquest of California, Travels in Oregon, and History of the Gold Regions. New York: Published by Nafis & Cornish. St. Louis, Mo.:—Van Dien & MacDonald. 1849.* [*Second Ed.*]

The old Padres seem to have united with their missionary zeal a strong sense of comfort and taste. They laid off a beautiful garden, a few rods from the church, surrounded it with a high substantial fence of stone laid in Roman cement, and planted it with limes, almonds, apricots, peaches, apples, pears, quinces, &c., which are now annually yielding their several fruits in abundance. Before the church they erected a series of concentric urn fountains, ten feet in height, from the top of which the pure liquid bursts, and falls from one to another till it reaches a large pool at the base; from this it is led off a short distance to the statue of a grisly bear, from whose mouth it is ejected into a reservoir of solid masonry, six feet wide and seventy long. From the pool at the base of the urn fountains water is taken for drinking and household use. The long reservoir is the theatre of the battling, plashing, laughing and scolding of the washing-day. Around these fountains are solid, cemented stone pavements, and ducts to carry off the surplus water. Nothing of the kind can be in better taste, more substantial, or useful.

Above the church and its cloisters, they brought the water around the brow of a green hill, in an open stone aqueduct, a rapid, noisy rivulet, to a square reservoir of beautiful masonry. Below, and adjoining this, are the ruins of the Padres' grist-mill. Nothing is left of its interior structure, but the large oaken ridgepole. Near the aqueduct which carries the water into the reservoir of the mills, stands a small stone edifice ten feet in length by six in width. This is the bath. Over the door, outside, is the representation of a lion's head, from which pours a beautiful jet of water. This little structure is in a good state of preservation. A cross surmounts it, as, indeed, it does everything used by the Catholic missionaries of these wilderness regions. Below the ruins of the grist-mill is another tank one hundred and twenty-feet square, by twenty deep, constructed like the one above. In this was collected water for supplying the fountains, irrigating the grounds below, and for the propulsion of different kinds of machinery. Below the mission was the tan-yard, to which the water was carried in an aqueduct, built on the top of a stone wall, from four to six feet high. . . . . Nothing but the church retains its ancient appearance. . . . . It is one hundred and sixty feet long by sixty in width. Its walls are eight feet in thickness. The height of the nave is forty feet. . . . . Immediately before the altar is a trapdoor, opening into the vaults, where are buried the missionary Padres. Over the altar are many rich images of the saints. Among them is that of San Francisco, the patron of the missions of Upper California. . . . . To the left of the altar is the sacristy, or priest's dressing-room. It is eighteen feet square. . . . .

A door in the eastern wall of the church leads from the foot of the chancel to the cemetery. It is a small piece of ground enclosed by a high wall, and consecrated to the burial of those Indians who die in the faith of the Catholic Church. It is curiously arranged. Walls of solid masonry, six feet apart, are sunk six feet in depth, and to a level with the surface. Between these the dead are buried in such manner that their feet touch one wall and their heads the other. These grounds have been long since filled. In order, however, that no Christian Indian may be buried in a less holy place, the bones, after the flesh has decayed, are exhumed and deposited in a little building on one corner of the premises. I entered this. Three or four cart-loads of skulls, ribs, spines, leg-bones, arm-bones, &c., lay in one corner. Beside them stood two hand-hearses with a small cross attached to each. About the walls hung the mould of death!

G. M. WASEURTZ AF SANDELS

On Pitch, Lime, and Adobe

1842-43 *

St. Innes is one of the Missions which yet remains with some live stock. I think 5,000 head of cattle, some horses, mares and sheep. . . . . Having stopt a few days on medical duties at this place, I returned and examined the Naptha Springs in the neighborhood of the town. A sort of broken ground surrounded with marshes end in an abrupt bluff a mile from the sea. There it opens as an excavation in the bottom of which naptha is issued in a dark boiling mass not unlike molasses. The strong smell from the spring do not enable one to stopp long for to examine the whole process. This mass issues, hardens and is brought away and used for roofing houses with. These roofs are very uncomfortable both for the volcanic smell and the inconvenience of its dropping down by the least heat of the sun forming a pitchy sticky stuff round the house on which it is employed. It might be employed and cured in a better way for avoiding this inconvenience. The naptha floats out at sea and in so strong and heavy quantity that it partly settles the stormy waves. . . . .

---

* The following short extracts and sketches are published herein by permission of The Society of California Pioneers, copyright owner, from the original manuscript, now in the collection of the Society, as published in their *Quarterly*, vol. 3, no. 2. Photos are by Mary Rae Hill.

Sandels' complete account has recently been issued under the sponsorship of The Book Club of California, and printed by Grabhorn Press [1945] as *A Sojourn in California by The King's Orphan—The Travels and Sketches of G. M. Waseurtz af Sandels, a Swedish Gentleman Who Visited California in 1842-43.*

"Several early Californians, Bidwell, Sutter, and others, have mentioned the visit in 1842-3 of an educated Swedish gentleman known as Dr. Sandels (G.M. Waseurtz of Sandels), who lived in Brazil, lost a fortune in mining operations in Mexico, and who declared that there was gold in the region of New Helvetia.

"Some time before the discovery of gold at Sutter's Mill, Sandels, evidently far gone in consumption, called on Col. T. B. Thorpe, a journalist in New Orleans, saying that he was, in his own country, one of the 'King's Orphans'. That is, he had been educated at a government institution, one of whose requirements was that the pupil, after receiving his education, should travel in foreign lands, record his impressions, and send the manuscript to the institution's archives. The manuscript, however, remained in the hands of Col. Thorpe, and later was given to the Associated Pioneers of the Territorial Days of California after being arranged in a scrap-book by Samuel C. Upham.

"It is a narrative of the author's voyage from Acapulco to Monterey in September 1842, and of his observations while traveling in California. . . . .

"Of the chronology of his movements not much is known save that he was in Sonoma in February or March 1843, and in Santa Barbara in April. In September of that year he sailed on the *Diamond* for Honolulu.

"This original manuscript with its delightful pencil and water color sketches, for Sandels was also an artist, is now in the possession of The Society of California Pioneers. A portion of it was published in the San Jose Pioneer in 1878-9, and another portion in a compilation in Upham's 'Notes on a voyage to California'. Such parts as we are giving here, however, are printed without change or correction, just as Sandels himself translated his story from the Swedish." From *The King's Orphan's Manuuscript, Translated from the Swedish by the Author, G. M. Waseurtz af Sandels,* in the Society of California Pioneers Quarterly vol. 3, no. 2, foreword, June 1926.

"Another incident I may mention. There arrived on this coast a certain Dr. Sandels a scientific gentleman. He was a Swede by birth but educated in London. . . . . The Doctor came as far north as Chico Creek with Mr. Dicky but did not examine the mountains except the Buttes. On his return he told Sutter that there were indications of gold but that unless the mountains on the sides were richer than those in the valley the mines would not pay to work." John Bidwell, in *California, 1841-8,* manuscript in the Bancroft Library, University of California.

FIGURE 41. COPPY OF A WOODCUT IN PADRE SERRAS DESCRIPTION OF CALIFORNIA REPRESENTING MONTEREY BAY.

[In the region of Mt. Diablo] . . . . . Next day I saddled my horse and went in search of the lime kilns and after having examined them, I went strolling about the country quite alone as customary, searching for minerals and looked at the formation of the hills. . . . . We landed now the lime and in two days put to sea again after having been obliged to tug or draw the scooner back through the slue for to come out in the bay.

[Sutter's Fort] . . . . . A two story roomy and convenient building is placed in the center of an enclosure of unbaked bricks or adobe, layed very thick, I believe about ten feet, having a turret with its embrazures and loopholes for fire arms which are provided plentifully, Mr. Sutter having purchased all the Russian establishment [Fort Ross] arms. All around the inside of the walls are erected living and store houses, most of them thatched with straw, schingles having been too scarce yet for covering more than the principle houses. A constant watch is kept at the ponderous gates by an armed servant dressed as a militia soldier.

FIGURE 42. PORT OF ST. DIEGO IN UPPER CALIFORNIA.

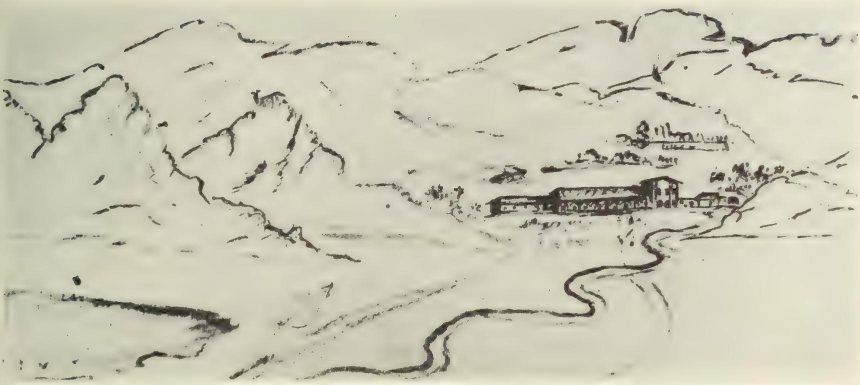


FIGURE 43. THE ORIGINAL PENCIL SKETCH OF THE R. CH. MISSION ST. LUIS OBISPO IN CALIFORNIA IN THE VALLEY OF BEARS, 1843 [?].

FIGURE 44. MISSION STA. CLARA ON THE BAY OF ST. FRANICO—CONTAINING 1500 INDIANS AND A GOOD STOCK OF CATTLE.

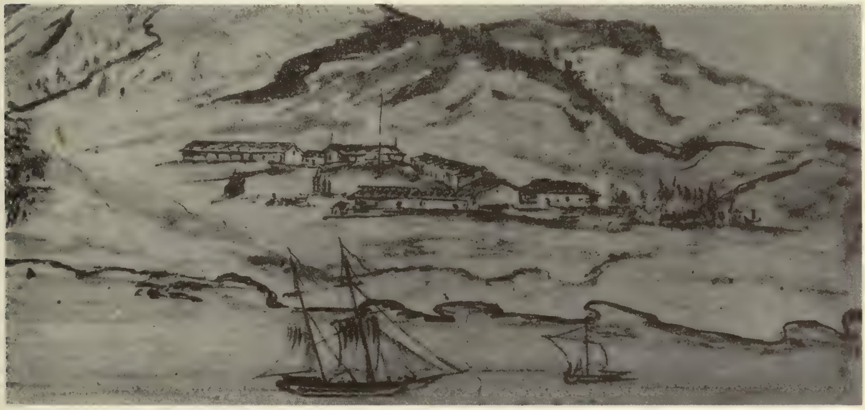
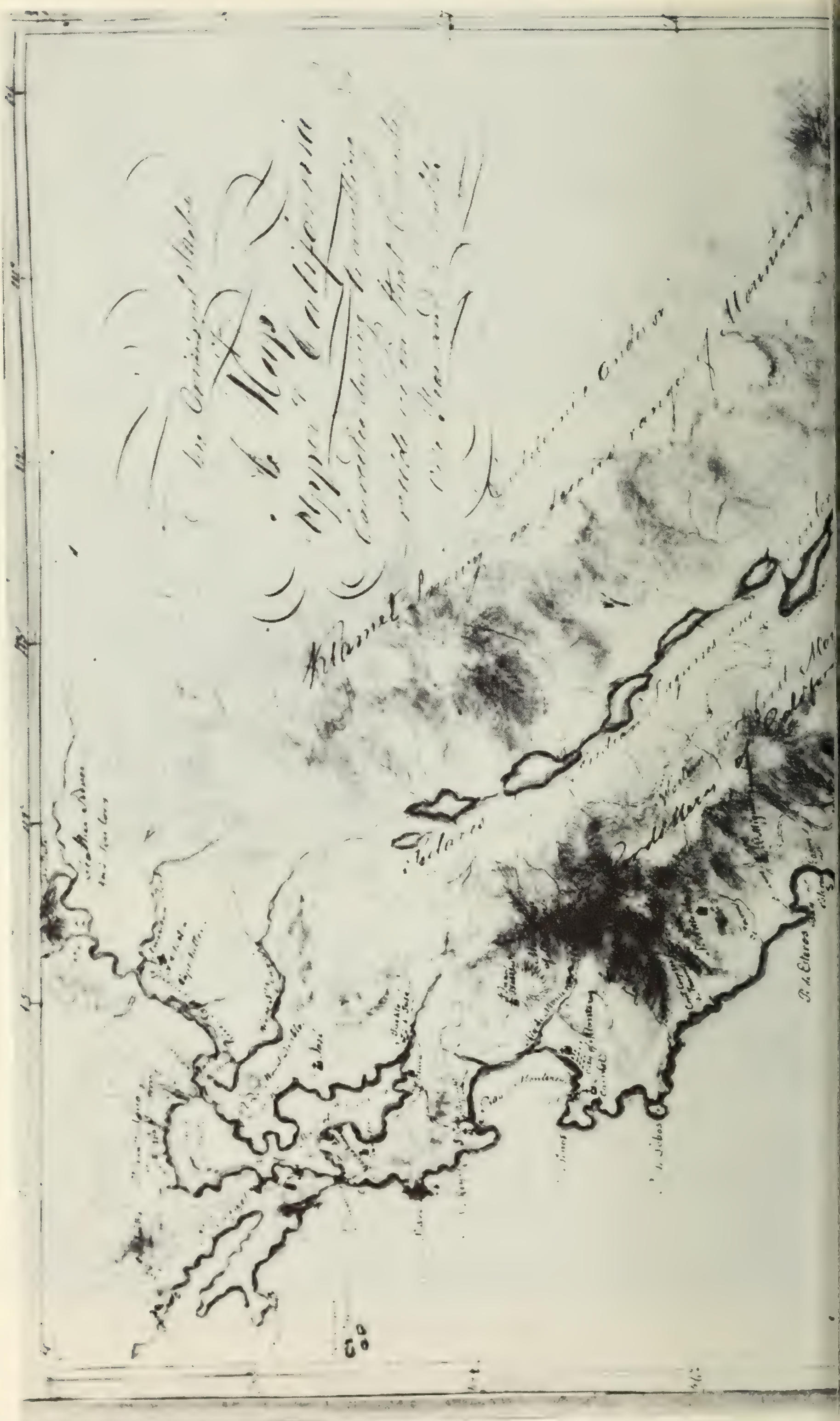


FIGURE 45. THE MILITARY BARACKS OF ST. FRANSISCO IN CALIFORNIA.



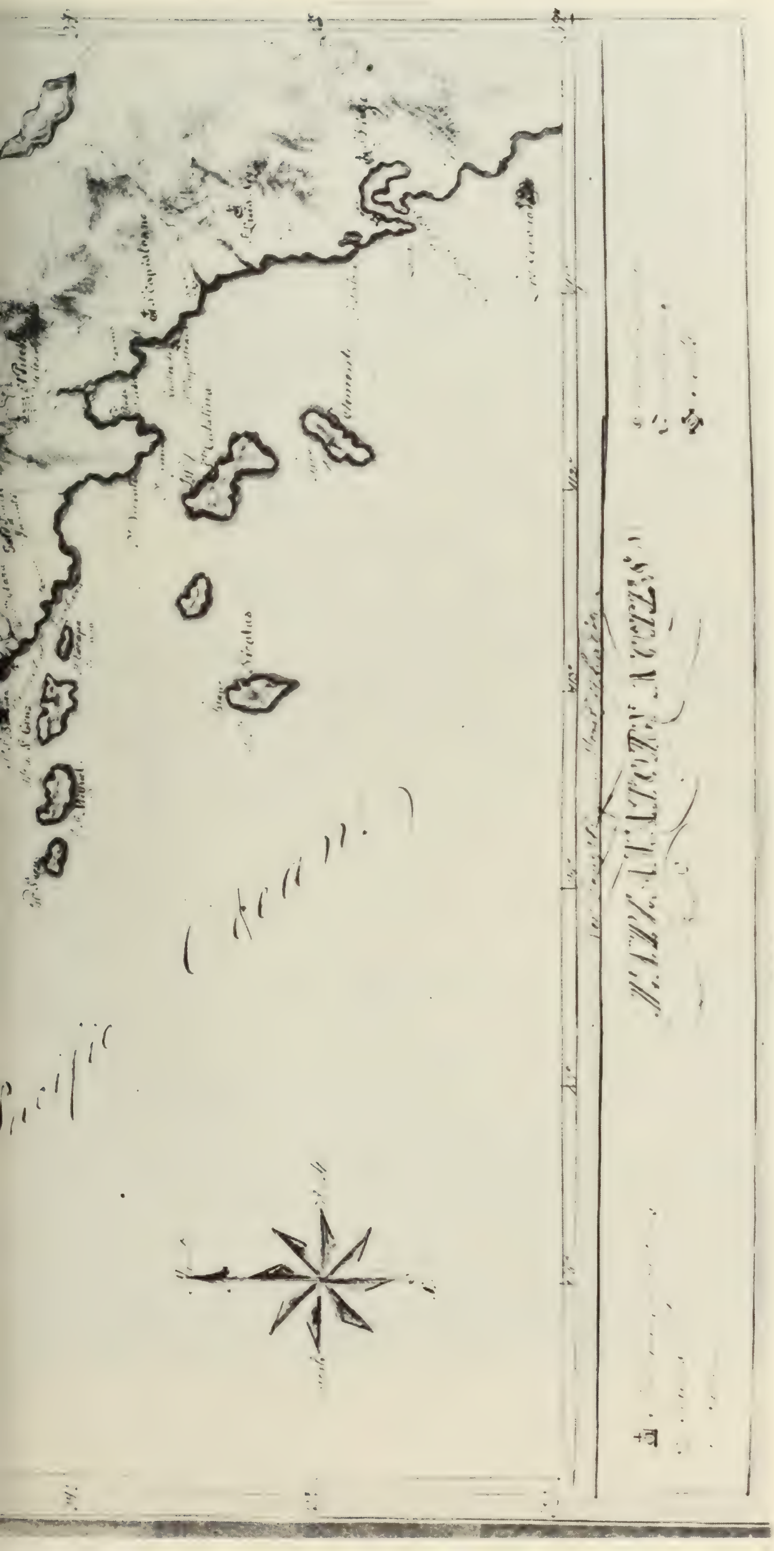


FIGURE 46. THE ORIGINAL SKETCH OF A MAP OF UPPER CALIFORNIA CORRECTED DURING TRAVELLING AND RESIDENCE IN THAT COUNTRY ONE YEAR AND A HALF.

FIGURE 47. ROUGH SKETCH OF A KITCHEN AND DINING ROOM ON A FARM IN CALIFORNIA.

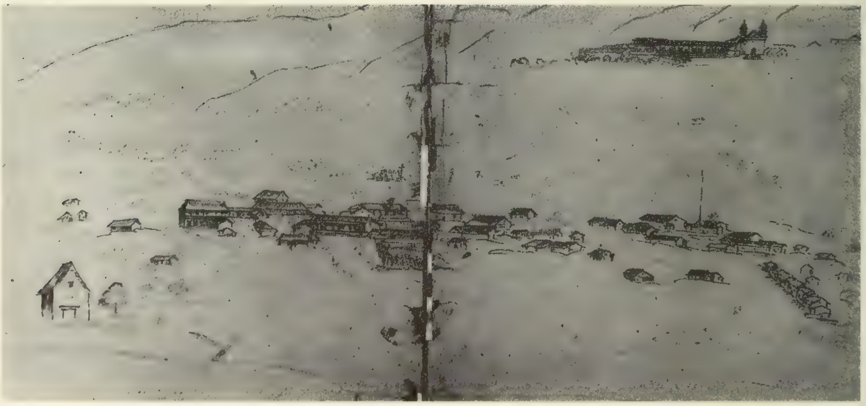


FIGURE 48. STA. BARBARA IN CALIFORNIA.

FIGURE 49. ORIGINAL PENCIL SKETCH OF FORT AND PORT OF ST. FRANSISCO IN CALIFORNIA.

FIGURE 50. PENN SKETCH OF THE TOWN AND CH[H] MISSION STA BARBARA IN CALIFORNIA 1844.

FIGURE 51. VISTA DEL PUEBLO DE LOS ANNGELES EN ALTA CALIFORNIA.

FIGURE 52. THE SEA TOWN AND PORT YERBA BUENA IN ST. FRANCICO BAY IN CALIFORNIA. Legend: (1) Hudson's Bay Co. building; (2) Old mill; (3) G. Reynold's residence; (4) Capt. Antonio Ortega's residence; (5) Wm. A. Leidesdorff cottage; (6) City Hotel (Wm. A. Leidesdorff); (7) Capt. John Paty's adobe building; (8) Juan C. Davis' residence; (9) Peter I. Sherback's residence; (10) Sill's blacksmith shop; (11) Jesus Noe's residence; (12) Old adobe custom house; (13) Juan N. Padilla's residence; (14) Leidesdorff warehouse; (15) W. H. Davis' store; (16) Capt. Wm. Hinckley's residence; (17) Gen. M. G. Vallejo's (or Ignacio Vallejo's) building.

EDWIN BRYANT

On Adobe Buildings at San Jose, Mission and Pueblo 1846 *

September 18 [1846].— . . . . . A *carretada* of fossil oyster shells was shown me by Mr. Livermore, which had been hauled for the purpose of being manufactured into lime. Some of these shells were eight inches in length, and of corresponding breadth and thickness. They were dug from a hill two or three miles distant, which is composed almost entirely of this fossil. Several bones belonging to the skeleton of a whale, discovered by Mr. L on the summit of one of the highest elevations in the vicinity of his residence were shown to me. The skeleton when discovered was nearly perfect and entirely exposed, and its elevation above the level of the sea between one and two thousand feet. . . . .

We . . . . . entered through a narrow street the mission of San José, or St. Joseph. Passing the squares of one-story adobe buildings, once inhabited by busy Indians, but now deserted, roofless, and crumbling into ruins, we reached the plaza in front of the church and the massive two-story edifices occupied by the *padres* during the flourishing epoch of the establishment. These were in good repair, but the doors and windows with the exception of one were closed, and nothing of moving life was visible except a donkey or two, standing near a fountain which gushed its waters into a capacious stone trough. . . . .

Belonging to the mission are two gardens, enclosed by high adobe walls. After dinner we visited one of these. The area of the enclosure contains fifteen or twenty acres of ground, the whole of which is planted with fruit-trees and grape-vines. . . . . The gardens are irrigated with very little trouble, from large springs which flow from the hills a short distance above them. Numerous aqueducts, formerly conveying and distributing water over an extensive tract of land surrounding the mission, are still visible, but as the land is not now cultivated, they at present contain no water.

The mission buildings cover fifty acres of ground, perhaps more, and are all constructed of adobes with tile roofs. Those houses or barracks which were occupied by the Indian families, are built in compact squares, one story in height. They are generally partitioned into two rooms, one fronting on the street, the other upon a court or corral in the rear. The main buildings of the mission are two stories in height, with wide corridors in front and rear. The walls are massive, and if protected from the winter rains, will stand for ages. But if exposed to the storms by the decay of the projecting roofs, or by leaks in the main roof, they will soon crumble, or sink into shapeless heaps of mud. I passed through extensive warehouses and immense rooms, once occupied for the manufacture of woollen blankets and other articles, with the rude machinery still standing in them, but unemployed. Filth and desolation have taken the place of cleanliness and busy life. The granary was very capacious, and its dimensions were an evidence of the exuberant fertility of the soil, when properly cultivated under the superintendence of the *padres*. The calaboose is a miserable dark room of two apartments, one with a small loophole in the wall, the other a dungeon without light or ventilation. The stocks, and several other inventions for the punishment of offenders, are still standing in this prison. I requested permission

* From *What I Saw in California: Being the Journal of a Tour, By the Emigrant Route and South Pass of the Rocky Mountains, Across the Continent of North America, the Great Desert Basin, and Through California, In the Years 1846, 1847. By Edwin Bryant, Late Alcalde of St. Francisco. Second Edition. New York: D. Appleton & Company, 200 Broadway. Philadelphia: Geo. S. Appleton, 148 Chesnut-Street. M DCC XL VIII.*

to examine the interior of the church, but it was locked up, and no person in the mission was in possession of the key. Its length I should suppose is from one hundred to one hundred and twenty feet, and its breadth between thirty and forty, with small exterior pretensions to architectural ornament or symmetry of proportions. . . . .

Sept. 19.— . . . . . We arrived at the Pueblo de San José about 12 o'clock. . . . . The Pueblo . . . . . is a village containing some six or eight hundred inhabitants. . . . . The buildings . . . . . with few exceptions, are constructed of adobes, and none of them have even the smallest pretensions to architectural taste or beauty. The church, which is situated near the centre of the town, exteriorly resembles a huge Dutch barn. The streets are irregular, every man having erected his house in a position most convenient to him. Aqueducts convey water from the Santa Clara river to all parts of the town. . . . .

The Pueblo de San José is one of the oldest settlements in Alta California. Captain Fisher pointed out to me a house built of adobes, which has been standing between 80 and 90 years, and no house in the place appeared to be more substantial or in better repair.

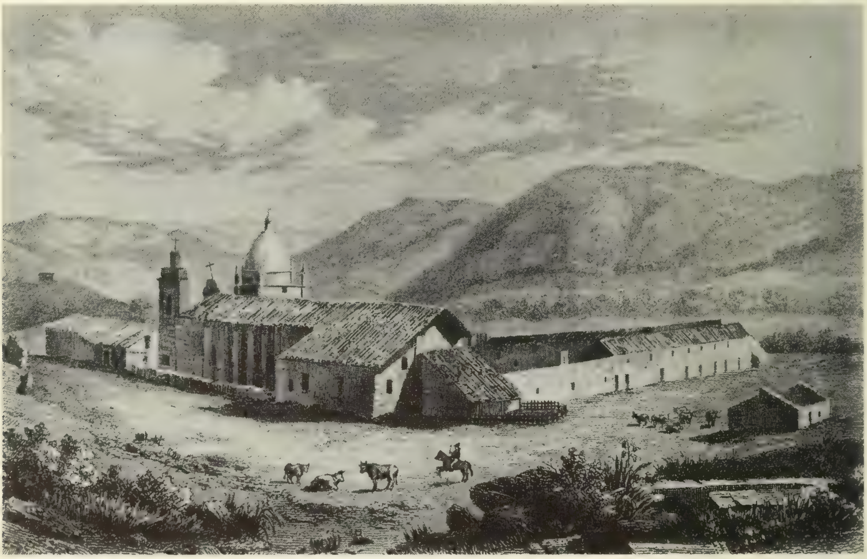


FIGURE 53. MISSION DE N-D. DU CARMEL AUX ENVIRONS DE SAN CARLOS DE MONTEREY, CALIFORNIE. Arthus Bertrand, Editeur. Voy. de l'Artémise. Tom. 6e. *From Campagne de circumnavigation de la frégate l'Artémise, pendant les années 1837, 1838, 1839 et 1840, sous le commandement de M. Laplace, Capitaine de Vaisseau, publié par ordre du Gouvernement, sous les auspices du Ministre de la Marine. Tome Sixième. Paris, Arthus Bertrand, Éditeur, Libraire de la Société de Geographie rue Hautefeuille, 21, 1854. Photo by courtesy of Bancroft Library, University of California.*

WALTER COLTON

On Adobe and Stone Construction at Monterey

1846-49 *

FRIDAY, JULY 17 [1846]. The bay of Monterey circles up broad and deep into the coast. It is far from being land-locked, and yet the southern bend is sufficiently sheltered to afford a safe and quiet anchorage. The town is built within a circling range of forest-feathered hills, and on a plain that descends in easy slopes to the strand of the bay. A more inviting picturesque location for a city never entered a poet's dream. The buildings are reared of adobes, covered with a white layer of lime; they are seldom over one story and a half, and are ornamented with porticoes running the entire front. The streets are broad but irregular, and the hills around connect themselves with the gleaming walls of cottages which as yet exist only in your imagination.

FRIDAY, JULY 31. Nearly all the houses in Monterey are of one story, with a corridor. The walls are built of adobes, or sun-baked brick, with tiled roofs. The centre is occupied by a large hall, to which the dining-room and sleeping apartments seem mere appurtenances. Every thing is in subordination to the hall, and this is designed and used for dancing. It has a wood floor, and springs nightly to the step of those who are often greeted in the whirl of their amusements, by the risen sun. The dance and a dashing horse are the two objects which overpower all others in interest with the Californians. The fiddle has been silent since our flag went up,† from the fact that many of the gentlemen have left to join Gen. Castro. But if they return, though covered with disaster, the fiddle will be called upon to resume its fantastic functions. You might as well attempt to extinguish a love of air in a life-preserver as the dancing propensity in this people.

THURSDAY, AUG. 27. Nothing puzzles me so much as the absence of a penitentiary system. There are no work-houses here; no buildings adapted to the purpose; no tools, and no trades. The custom has been to fine Spaniards, and whip Indians. The discrimination is unjust, and the punishment ill suited to the ends proposed. I have substituted labor; and have now eight Indians, three Californians, and one Englishman at work making adobes. They have all been sentenced for stealing horses or bullocks. I have given them their task: each is to make fifty adobes a day, and for all over this they are paid. They make seventy-five, and for the additional twenty-five each gets as many cents. This is paid to them every Saturday night, and they are allowed to get with it any thing but

---

* From *Deck and Port; or, Incidents of a Cruise in the United States Frigate Congress to California. With Sketches of Rio Janeiro, Valparaiso, Lima, Honolulu, and San Francisco. By Rev. Walter Colton, U.S.. New York: Published by A. S. Barnes & Co., No. 51 John-Street. Cincinnati:—H. W. Derby & Co. 1850.* And from *Three Years in California. By Rev. Walter Colton, U.S.N., Late Alcalde of Monterey; Author of "Deck and Port," etc., etc. With Illustrations. New York: Published by A. S. Barnes & Co. No. 51 John-Street. Cincinnati:—H. W. Derby & Co. 1850.*

The first book is Colton's Journal of the voyage from Norfolk, Virginia, around Cape Horn, to San Francisco, and covers the period October 1845 to July 1846. The second book is a continuation of the Journal, kept from July 1846 to June 1849, when Colton was Alcalde of Monterey.

† Colton here refers to the raising of the American flag at Monterey by Commodore Sloat, which occurred about a week before the arrival of the *Congress* at that port.

FIGURE 54. SAN FRANCISCO IN 1846. Coltons Deck & Port. Lith. of Sarony. *Photo by courtesy of Bancroft Library, University of California.*

FIGURE 55. SURROUNDINGS OF MISSION DOLORES, 1849, engraved from a print published in 1850. *Photo by Mary Rae Hill, from the collection of the Society of California Pioneers.*

FIGURE 56. MONTEREY—CAPITOL OF CALIFORNIA [1846]. Sketched by J. W. Revere U.S.N. Lith. of Wm. Endicott & Co. N. York. Published by C. S. Francis & Co. N. York. *Photographed from "A Tour of Duty in California", by Joseph Warren Revere, Lieutenant, U. S. Navy, New York, 1849, in the library of The Society of California Pioneers, by Mary Rae Hill.*

FIGURE 57. SUTTER'S FORT—NEW HELVETIA [1846]. Sketched by J. W. Revere U.S.N. Lith. of Wm. Endicott & Co. N. York. Published by C. S. Francis & Co. N. York. *Photographed from "A Tour of Duty in California", by Joseph Warren Revere, Lieutenant, U. S. Navy, New York, 1849, in the library of The Society of California Pioneers, by Mary Rae Hill.*

rum. They are comfortably lodged and fed by the government. I have appointed one of their number captain. They work in the field; require no other guard; not one of them has attempted to run away.

WEDNESDAY, MARCH 4 [1847] . . . . . I shall set the prisoners quarrying stone for a school-house, and have already laid the foundations. The building is to be sixty feet by thirty—two stories, suitably proportioned, with a handsome portico. The labor of the convicts, the taxes on rum, and the banks of the gamblers, must put it up. Some think my project impracticable; we shall see.

MONDAY, APRIL 12. The old prison being too confined and frail for the safe custody of convicts, I have given orders for the erection of a new one. The work is to be done by the prisoners themselves; they render the building necessary, and it is but right they should put it up. Every bird builds its own nest. The old one will hold an uninventive Indian, but a veteran from Sidney or Sing Sing would work his way out like a badger from his hole, which the school urchin had obstructed. I had an experience with one a few nights since, and he went through the roof with ball and chain. How he ever reached the rafters, unless the man in the moon magnetized him, I cannot conjecture. But out he got, and it cost me a California chase to catch him.

WEDNESDAY, MAY 12. A nest of gamblers arrived in town yesterday, and last evening opened a monte at the hotel honored with the name of the Astor House. I took a file of the soldiers, and under cover of night reached the hotel unsuspected, where I stationed them at the two doors which afforded the only egress from the building. In a moment I was on the stairs which lead to the apartment where the gamesters were congregated. I heard a whistle, and then footsteps flying into every part of the edifice. On entering the great chamber, not a being was visible save one Sonoranian reclining against a large table smoking his cigarito. I passed the complements of the evening with him, and desired the honor of an introduction to his companions.

At this moment a feigned snore broke on my ear from a bed in the corner of the apartment—"Ha! Dutre, is that you? Come, tumble up, and aid me in stirring out the rest." He pointed under the bed, where I discovered, just within the drop of the valance a multitude of feet and legs radiating as from a common centre. "Hallo there, friends—turn out!" and out came some half-dozen or more, covered with dust and feathers, and odorous as the nameless furniture left behind. Their plight and discovery threw them into a laugh at each other. From this apartment, accompanied by my secretary, I proceeded to others, where I found the sleepers stowed away in every imaginable position—some in the beds, some under them, several in closets, two in a hogshead, and one up a chimney. Mr. R——, from Missouri—known here under the soubriquet of "the prairie wolf"—I found between two bed-ticks, with his coat and boots on, and half smothered with the feathers. He was the ringleader, and raises a monté table wherever he goes as regularly as a whale comes to the surface to blow. All shouted as he tumbled out from his ticks. Among the rest I found the alcalde of San Francisco, a gentleman of education and refinement, who never plays himself, but who, on this occasion, had come to witness the excitement. I gathered them all, some fifty in number, into the large saloon, and told them the only speech I had to make was in the shape of a fine of twenty dollars each. The more astute began to demur on the plea of not guilty, as no cards and no money had been discovered; and as for the beds, a man had as good a right to sleep under one as in it. I told them that was a matter of taste, misfortune often made strange bedfellows, and the only way to get out of the scrape was to pay up. Dr. S——

FIGURE 58. Colton Hall, Monterey. *Photo from the collection of the California Historical Society.*

was the first to plank down. "Come, my good fellows," said the doctor, "pay up, and no grumbling; this money goes to build a schoolhouse, where I hope our children will be taught better principles than they gather from the example of their fathers." The "prairie-wolf" planked down next, and in ten minutes the whole, Chillanos, Sonoranians, Oregonians, Californians, Englices, Americanos, delivered in their fines. These, with the hundred dollar fine of the keeper of the hotel, filled quite a bag. With this I bade them good night, and took my departure. I hope the doctor's prediction will prove true; certainly it shall not be my fault if it turns out a failure. In all this there was not an angry look or petulant remark; they knew I was doing my duty, and they felt that they atoned in part for a violation of theirs through their fines. If you must hold office be an alcalde, be absolute, but be upright, impartial, and humane.

FRIDAY, JUNE 18. One of the prisoners, who is an Englishman, ventured a criticism on the stonework of another prisoner, which revealed the fact of his being a stonecutter himself. I immediately sat him at work at his old trade. But he feigned utter ignorance of it, and spoiled several blocks in making his feint good. I then ordered him into a deep well, where the water had given out, to drill and blast rocks. He drove his drills here for several days, and finding that the well was to be sunk some twenty or thirty feet deeper, concluded it was better for him to work in the upper air, and requested that he might be permitted to try his chisel again. Permission was given, and he is now shaping stones fit to be laid in the walls of a cathedral. He was taken up for disorderly conduct, and he is now at work on a schoolhouse, where the principles of good order are the first things to be taught.

TUESDAY, MARCH 8 [1849]. The town-hall, on which I have been at work for more than a year, is at last finished. It is built of white stone, quarried from a neighboring hill, and which easily takes the shape you desire. The lower apartments are for schools; the hall over them—seventy feet by thirty—is for public assemblies. The front is ornamented with a portico, which you enter from the hall. It is not an edifice that would attract any attention among public buildings in the United States; but in California it is without a rival. It has been erected out of the slender proceeds of town lots, the labor of the convicts, taxes on liquor shops, and fines on gamblers. The scheme was regarded with incredulity by many; but the building is finished, and the citizens have assembled in it,

and christened it after my name, which will now go down to posterity with the odor of gamblers, convicts, and tipplers. I leave it as humble evidence of what may be accomplished by rigidly adhering to one purpose, and shrinking from no personal efforts necessary to its achievement. A prison has also been built, and mainly through the labor of the convicts. Many a joke the rogues have cracked while constructing their own cage; but they have worked so diligently I shall feel constrained to pardon out the less incorrigible. It is difficult here to discriminate between offenses which flow from moral hardihood, and those which result, in a measure, from untoward circumstances. There is a difference in the turpitude of the two; and an alcalde under the Mexican law, has a large scope in which to exercise his sense of moral justice. Better to err a furlong with mercy than a fathom with cruelty. Unmerited punishment never yet reformed its subject; to suppose it, is a libel on the human soul.

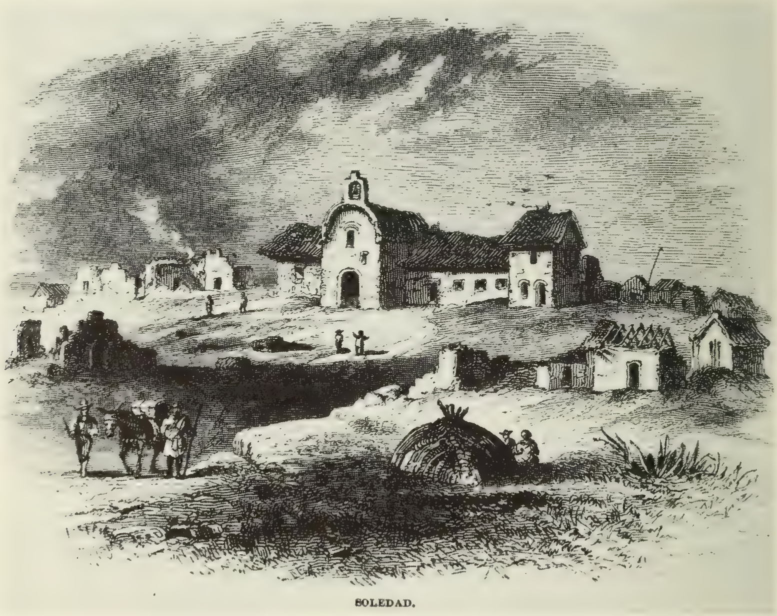


FIGURE 59. SOLEDAD [1849]. A more desolate place than Soledad can not well be imagined. The old church is partially in ruins, and the adobe huts built for the Indians are roofless, and the walls tumbled about in shapeless piles. Not a tree or shrub is to be seen any where in the vicinity. The ground is bare, like an open road, save in front of the main building (formerly occupied by the priests), where the carcasses and bones of cattle are scattered about, presenting a disgusting spectacle. . . . . From *A Dangerous Journey, in Crusoe's Island: A Ramble in the Footsteps of Alexander Selkirk. By J. Ross Browne, Author of "Etchings of a Whaling Cruise," "Yusef," &c. New York: Harper & Brothers, Publishers, Franklin Square. 1864. Photo by courtesy of California State Library.*

WILLIAM RICH HUTTON

Sketches of California Buildings as They Appeared

1847-52

William Rich Hutton of Washington, D. C., came to California in 1847 and remained until 1852, working as clerk to his uncle, an army paymaster, and also as a surveyor and draftsman. Ninety-five of his pencil drawings and water-colors, the majority of which depict scenes in California during the early years of American occupation and statehood, are now in the collection of the Henry E. Huntington Library and Art Gallery, in San Marino; forty-six of them have been published in *California, 1847-1852, Drawings by William Rich Hutton Reproduced from the Originals in the Huntington Library: San Marino, California, 1942.*

All of Hutton's drawings published herein, with the exception of the first (*The Mission of San Gabriel in California*), are reproduced from the originals in The Huntington Library collection, by courtesy of the Library.

FIGURE 60. THE MISSION OF SAN GABRIEL IN CALIFORNIA, DRAWN BY WILLIAM HUTTON OF WASHINGTON CITY. *Photo from the collection of the California Historical Society.*

FIGURE 61. SAN LUIS REY. MARCH 17, 1848.

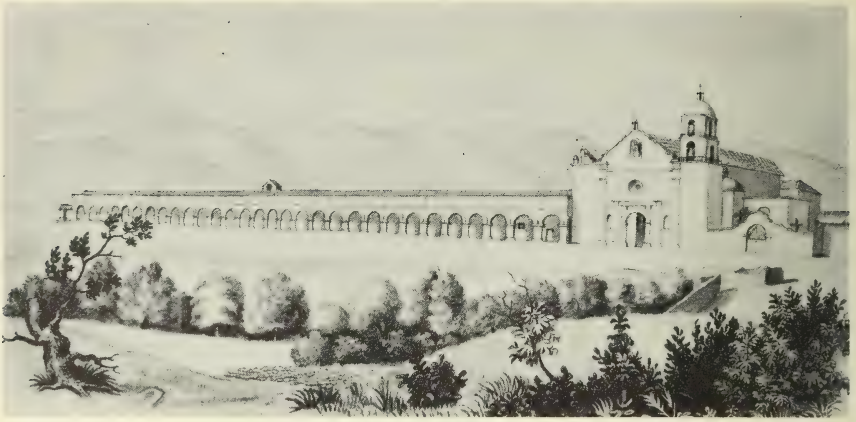


FIGURE 62. SAN LUIS REY, 1848. MISSION OF ST. LOUIS (THE KING)—LONGEST BUILDING IN CALIFORNIA.

FIGURE 63. FORT MOORE. AMERICAN FORT AT PUEBLO DE LOS ANGELES FROM MR. PRYOR'S HOUSE—JULY 10, 1847.

FIGURE 64. LOS ANGELES PUEBLO—PART OF TOWN AND VINEYARDS, 1847.

FIGURE 65. LOS ANGELES, APRIL 1848.

FIGURE 66. PART OF LOS ANGELES, 1847.

FIGURE 67. SANTA BARBARA, 1848.

FIGURE 68. MISSION SANTA BARBARA.

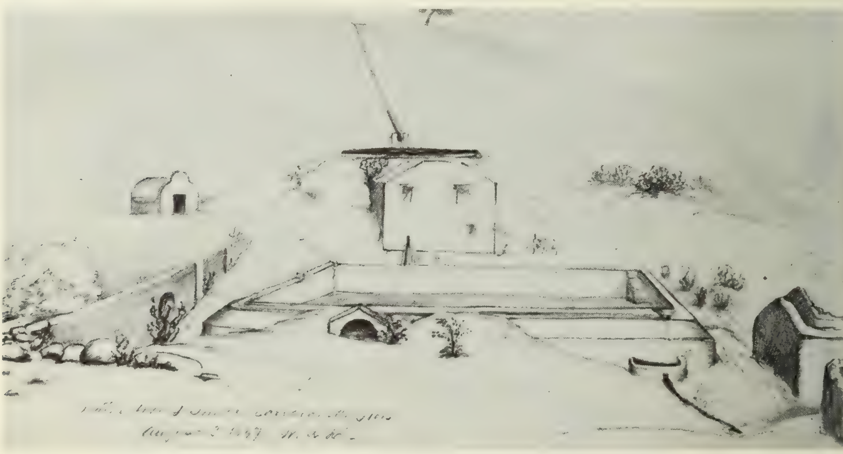


FIGURE 69. WATER WORKS, SANTA BARBARA MISSION, AUGUST 3, 1847.

FIGURE 70. SANTA BARBARA MISSION—FROM THE HILL—(ISLAND OF SANTA CRUZ IN DISTANCE, 25 MILES). 1852.

FIGURE 71. SANTA BARBARA FROM THE ANCHORAGE, JUNE 30, 1847.

FIGURE 72. MISSION OF SAN LUIS OBISPO, DEC. 3, 1850.

FIGURE 73. MISSION OF ST. LOUIS (THE BISHOP) ABOUT THE MIDDLE OF OLD TERRITORY—S. LUIS OBISPO. DEC. 27, 50.

FIGURE 74. SAN CARLOS DE MONTERREY. CARMEL MISSION. 1847.

FIGURE 75. CARMEL MISSION, JUNE 3, 1847. (Perhaps Stanley's sketch, 1847.)

FIGURE 76. MISSION OF ST. CHARLES (CARMEL) NEAR MONTEREY—LOOKING N.E. MISSION DE SAN CARLOS, RIO CARMELO, JUNE 3d 1847.

FIGURE 77. SAN CARLOS DE MONTERREY (CARMELO).

FIGURE 78. MONTEREY IN 1849.

FIGURE 79. MONTEREY, CALIFORNIA—1849.

FIGURE 80. CUSTOM HOUSE, MONTEREY, 1848.

FIGURE 81. CHURCH OF ———— AT MONTEREY, MAY 18 [?], 1847. [La Capilla Reál, or Church of San Carlos, the Presidio church in Monterey.]

FIGURE 82. SAN FRANCISCO IN 1847, FROM RINCON POINT.

FIGURE 83. MISSION HOUSE OF ST. JOHN BAPTIST, SEPT. 29th 1847.

FIGURE 84. MISSION OF S. JUAN BAUTISTA. SEPT. 20 ,1847. ST. JOHN BAPTIST NORTH OF MONTEREY.

FIGURE 85. SAN FRANCISCO IN 1847—FROM THE HILL BACK. SEPT.

FIGURE 86. SUTTER'S FORT IN APRIL, 1849.

H. M. T. POWELL

Sketches of California Missions and Pueblos

March-April 1850

The following sketches by H. M. T. Powell and the captions which accompany them are published herein by permission of The Grabhorn Press, copyright owner; Mr. Thomas W. Norris, owner of Powell's original *Journal;* and The Book Club of California. With the exception of the picture that accompanies the description of Soledad Mission, they are reproduced from *The Santa Fé Trail to California, 1849-1852: The Journal and Drawings of H. M. T. Powell, Edited by Douglas S. Watson; San Francisco, The Book Club of California, E. & R. Grabhorn, Publishers: 1931.*

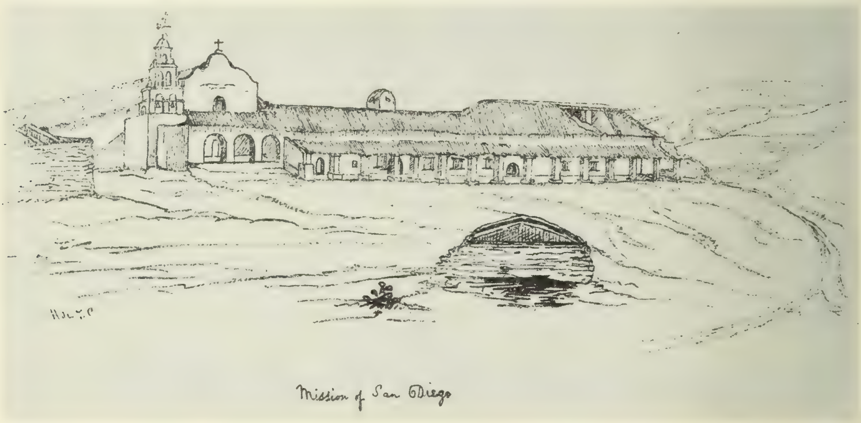


FIGURE 87. MISSION OF SAN DIEGO. *Photo by courtesy of California State Library.*

FIGURE 88. FLORES. "At a short distance we saw a Mission that we supposed to be the Mission of San Juan Capistrano. We stopped for the night by a small stream a little West of a small rancho. . . . . Here we met the Mail Rider who said we were 22 Miles from San Juan Capistrano and that what we took for San Juan nearby was Flores. . . . . About 1 league brought us to the little Mission of 'Flores'. Took a hasty sketch." [March 12-13, 1850]. *Photo by courtesy of California State Library.*

FIGURE 89. SAN LUIS REY. "The Mission is a very extensive quadrangle, enclosing about 2 acres, with colonnade all around the interior. . . . . The Mission is built of brick and adobe. Can tell best of its appearance by my sketch." [March 12, 1850]. ***Photo by courtesy of California State Library.***

FIGURE 90. SAN JUAN DE CAPISTRANO. ". . . . . Stopped a while at the Mission which is close by the river. The Church is built of gray stone, but is in ruins from an earthquake some years since. Many old adobe houses around, tiled with semi-cylindrical tiles common in this country. . . . . With difficulty took a slight sketch, rain hindered me from taking a good one." [March 13, 1850]. ***Photo by courtesy of California State Library.***

FIGURE 91. SAN DIEGO CITY. *Photo by courtesy of California Historical Society.*

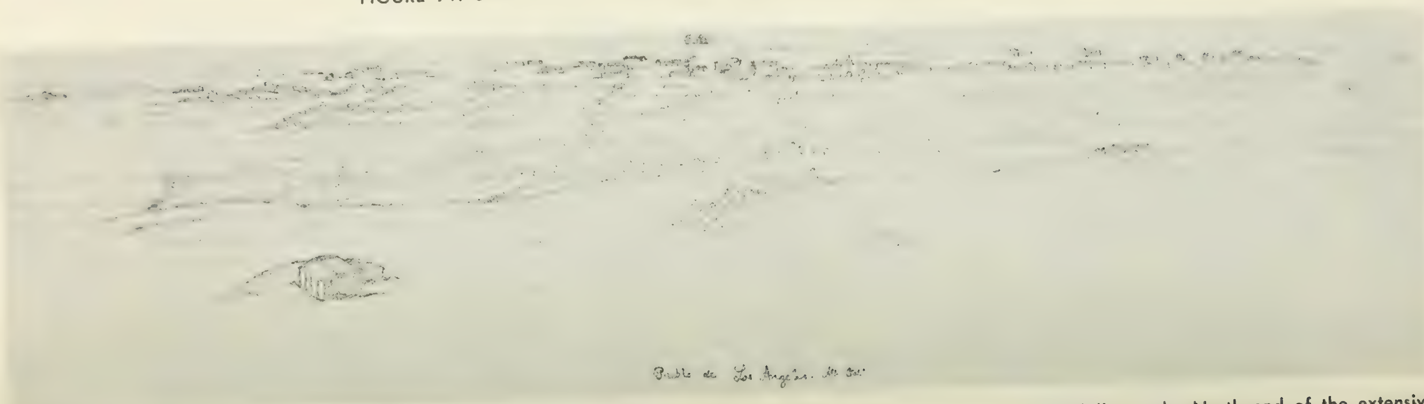


FIGURE 92. PUEBLO DE LOS ANGELES. "The Pueblo de Los Angeles is situated in a valley between some rolling hills, at the North end of the extensive Plain. . . . . The houses are roofed with pitch got from a spring some 6 Miles West. Went over the river and took a sketch of the town." [March 16-17, 1850]. *Photo by courtesy of California Historical Society.*

FIGURE 93. SANTA BARBARA. [March 25, 1850]. *Photo by courtesy of California Historical Society.*

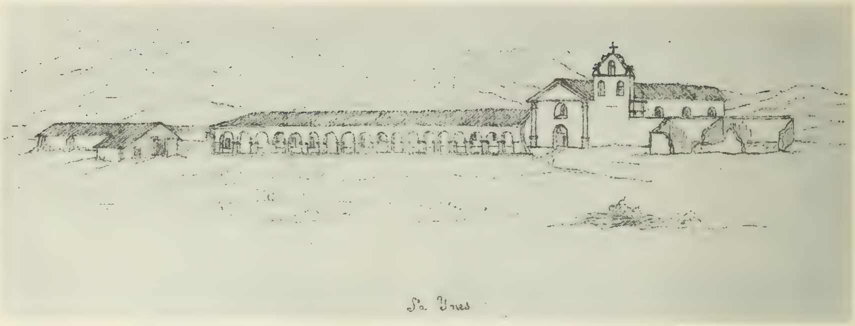


FIGURE 94. SA YNES. "I did not go into the Church but took a sketch. . . . . There a great many large water tanks around the Mission." [March 28, 1850]. *Photo by courtesy of California State Library.*

FIGURE 95. SAN LUIS OBISPO. [April 1, 1850]. *Photo by courtesy of California State Library.*

FIGURE 96. "SUNDAY. . . . . 8 Miles of Plain brought us to what looked like the bed of a mighty river, ½ Mile wide at least, with banks on each side, some 20 feet deep. 3 streams ran down the middle of this. Ring says they were dry when he passed last September. . . . . An acequia starts from here for the Mission, so that I think there must be a living stream above, (it is called 'Arroyo Seco'), but that it is lost in the sand down below here late in the summer and fall. Turned down this vast river bed into the immediate bottom of Buenaventura river, following it near the acequia 5 Miles to Mission of the 'Soledad'. The Mission is a mere ruin. No attempt at architectural ornament. Looks like a large rancho. Some adobe houses around." [April 7, 1850; a sketch of Soledad was made April 8.] *Photo (Soledad Mission?) by courtesy of Mr. Thomas W. Norris.*

FIGURE 97. SAN MIGUEL. "About 2 Miles. . . . . brought us to the Mission of 'San Miguel.' Took a sketch. I could not see the Church, as for some reason or other my horse became so frightened and unruly when near it that he was almost ungovernable. It was with difficulty that I could force him to pass through the large square." [April 4, 1850]. *Photo by courtesy of California State Library.*

FIGURE 98. SAN JUAN [BAUTISTA]. ". . . . . I took a very unsatisfactory sketch of the Mission of San Juan. There was no place for a point of view; all around being lower than the actual spot where the Mission and its buildings stood. I could only take a view of the Church and colonnade and front of the Mission buildings, which form one side of a square." [April 9, 1850]. *Photo by courtesy of California State Library.*

FIGURE 99. MISSION OF SANTA CLARA. *Photo by courtesy of California State Library.*

FIGURE 100. MISSION OF BUENAVENTURA. "Our way to the Mission of San Buenaventura was across a Plain through vast fields and tracts of mustard. . . . . About 8 Miles to the Mission Church; 45 paces long, 9 broad, height in proportion; numbers of paintings in gilded frames. The altar place is Corinthian, painted and gilded elaborately. . . . . Number of adobe houses; fine large gardens as usual with adobe walls; olive, pear and peach trees. Took a sketch." [March 22, 1850]. *Photo by courtesy of California State Library.*

FIGURE 101. MISSION OF SA BARBARA. "Went to the Mission about a Mile and half from the town. Took a sketch of it from a rock on the side hill and then turning round took a sketch of the town and Bay." [March 25, 1850]. *Photo by courtesy of California State Library.*

IN RETROSPECT
1850-1900

FIGURE 102. SANTA CLARA MISSION IN 1849, painted by Andrew P. Hill [1891]. The original painting is at Santa Clara University. *Photo from the collection of The Society of California Pioneers.*

FIGURE 103. SANTA CRUZ MISSION. From a painting by Toussaint. *Photo from the collection of The Society of California Pioneers.*

PAINTINGS AND SKETCHES BY VARIOUS ARTISTS
1850-1900

Since the close of the year 1850, many artists have taken up the pencil, pen, or brush to preserve on paper or canvas likenesses of the constructions of Spanish and Mexican days. Those whose works are included *In Retrospect* made a sincere attempt to produce accurate representations of the buildings, either as they saw them after 1850, or as they interpreted them from old records and from the recollections of persons familiar with them in earlier years.

FIGURE 104. LOS ANGELES. U.S.P.R.R. Exp. & Surveys—Cal. Plate X. From *Report of Explorations in California for Railroad Routes to Connect with the Routes Near the 35th and 32d Parallels of North Latitude, by Lieutenant R. S. Williamson, Corps of Topographical Engineers, 1853. Photo by Mary Rae Hill.*

FIGURE 105. MISSION OF SAN DIEGO. U.S.P.R.R. Exp. & Surveys—Cal. Plate XII. From *Report of Explorations in California for Railroad Routes to Connect with the Routes Near the 35th and 32d Parallels of North Latitude, by Lieutenant R. S. Williamson, Corps of Topographical Engineers, 1853. Photo by Mary Rae Hill.*

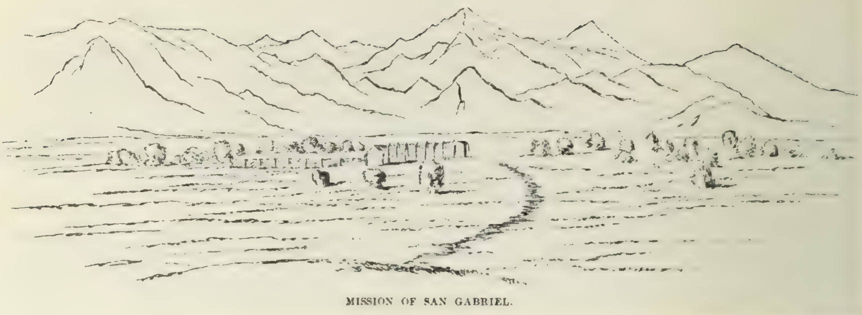


FIGURE 106. MISSION OF SAN GABRIEL. From *Report of Explorations in California for Railroad Routes to Connect with the Routes Near the 35th and 32d Parallels of North Latitude, by Lieutenant R. S. Williamson, Corps of Topographical Engineers, 1853. Photo by Mary Rae Hill.*

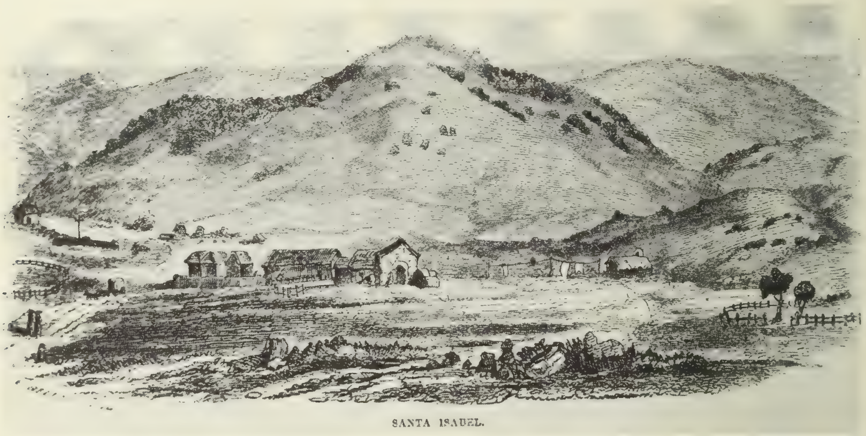


FIGURE 107. SANTA ISABEL [Asistencia to Mission San Diego]. . . . . Adobe buildings of great size were erected here in the time of the Padres, but are now partly in ruins. From *Report of Explorations in California for Railroad Routes to Connect with the Routes Near the 35th and 32d Parallels of North Latitude, by Lieutenant R. S. Williamson, Corps of Topographical Engineers, 1853. Photo by Mary Rae Hill.*

FIGURE 108. MISSION SANTA CLARA [in the early fifties]. W. H. Bartholomew. From *Pantoscope of California: A "Lecture" Together With Pencil Sketches Depicting the Journey Across the Plains to California, by J. Wesley Jones. Photo from the collection of the California Historical Society.*

FIGURE 109. THE PLAZA AT SONOMA. *From a water-color in the collection of the California Historical Society.*

FIGURE 110. MISSION DOLORES IN 1856. From a drawing by W. H. Bull. *Photo from the collection of The Society of California Pioneers.*

FIGURE 111. MISSION SAN DIEGO, 6 MILES FROM THE PACIFIC COAST. *Reproduced from a sketch by Alden, by courtesy of California Historical Society.*

FIGURE 112. MISSION SANTA BARBARA, JUNE 1855. From a water-color by J. M. Alden. *Reproduced by permission of Old Mission, Santa Barbara.*

FIGURE 113. CHAPEL OF THE PRESIDIO OF SANTA BARBARA, JUNE 1855. From a water-color by J. M. Alden. The presidio was founded April 21, 1872. The chapel was abandoned in 1855, because of its state of disrepair. *Reproduced by permission of Old Mission, Santa Barbara.*

FIGURE 114. THE MISSION SAN BUENAVENTURA, 1855. Painted by Lt. James Alden of the U. S. Coast Survey. *Reproduced from the original in the collection of the California Historical Society.*

PAINTINGS AND SKETCHES BY EDWARD VISCHER
1855-85

Figures 115 to 149, reproductions of sketches and paintings by Edward Vischer, have been obtained from the collections of photographs at The Society of California Pioneers, California Historical Society, and Huntington Library. A set of Vischer's original paintings is in the collection of the Bancroft Library, University of California, at Berkeley.

In 1872, in his *Missions of Upper California, 1872: Notes on the Californian Missions, a Supplement to Vischer's Pictorial of California,* Vischer made the following comments on his drawings:

"With the exception of San Diego, Santa Clara, and Mission of Dolores, which . . . . . are reproductions of earlier originals, the whole of the collection consists of our own drawings, mostly in 1865, when we visited the Southern Counties for that avowed purpose. All those sketches we tried to enliven with scenes of the olden times and incidents of Spanish and Mexican life; the groupings in many instances being portraits drawn from actuality or recollection."

FIGURE 115. RUINS OF THE PRESIDIO OF SAN DIEGO. . . . . AT THE ENTRANCE OF MISSION VALLEY, 1874. *Photo from the collection of The Society of California Pioneers.*

FIGURE 116. CHURCH RUIN. WALLS AND ORCHARD-GROUNDS OF SAN DIEGO. . . . . MISSION. *Photo from the collection of The Society of California Pioneers.*

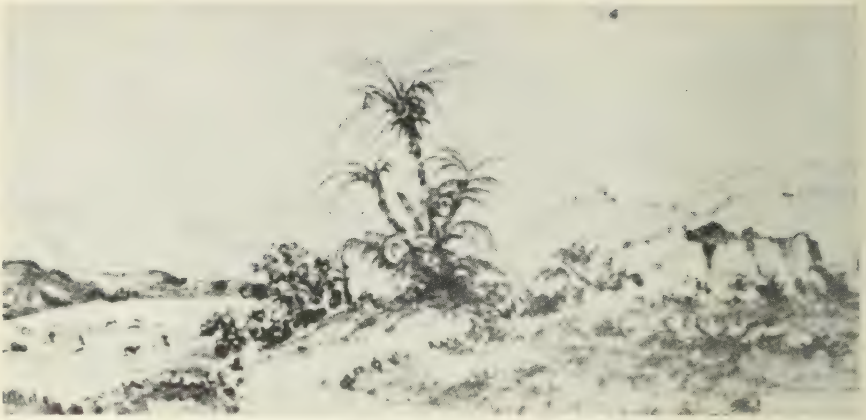


FIGURE 117. MISSION SAN DIEGO. Distant view of the ruins from the river land in Mission Valley. *Photo from the collection of The Society of California Pioneers.*

FIGURE 118. INDIAN RANCHERIA. . . . . MISSION SAN LUIS REY. *Photo from the collection of The Society of California Pioneers.*

FIGURE 119. RUINS OF THE CHURCH AND BUILDINGS OF THE MISSION OF SAN LUIS REY. *Photo from the collection of The Society of California Pioneers.*

FIGURE 120. VIEW OF THE OLD ORCHARDS AND THE CHURCH OF THE EX-MISSION OF SAN GABRIEL. Reminiscences of our first visit at San Gabriel, 1842. No traces left of the mission buildings. *Photo from the collection of the California Historical Society.*

FIGURE 121. SAN JUAN CAPISTRANO, 1858. *Photo from the collection of The Society of California Pioneers.*

FIGURE 122. RUINS OF THE CHURCH AND BUILDINGS OF THE EX-MISSION OF SAN LUIS REY. *Photo from the collection of The Society of California Pioneers.*

FIGURE 123. CHAPEL AND PRINCIPAL BUILDINGS OF THE EX-MISSION SAN FERNANDO. *Photo from the collection of The Society of California Pioneers.*

FIGURE 124. MISSION SAN BUENAVENTURA, sketched in May 1865. *Photo from the collection of The Society of California Pioneers.*

FIGURE 125. MISSION CHURCH OF SAN BUENAVENTURA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 126. MISSION RUINS. The dilapidated guardhouse at the Santa Barbara Mission. View towards the bay. Sketched April 1865. Supplementary drawings of 1873. *Photo from the collection of The Huntington Library.*

FIGURE 127. MISSION SANTA BARBARA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 128. MISSION SANTA BARBARA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 129. MISSION SANTA BARBARA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 130. STA. INES MISSION BUILDINGS. *Photo from the collection of The Society of California Pioneers.*

FIGURE 131. MISSION SAN LUIS OBISPO. Western part of the town and the Mission, 1864. *Photo from the collection of The Society of California Pioneers.*

FIGURE 132. SANTA INES, 1865. North view of the church and ex-mission. *Photo from the collection of The Society of California Pioneers.*

FIGURE 133. SAN MIGUEL, 1865. *Photo from the collection of The Society of California Pioneers.*

FIGURE 134. SANTA MARGARITA, RANCHO DE LA EX-MISSION DE SAN MIGUEL. Sketched May 1864. *Photo from the collection of The Society of California Pioneers.*

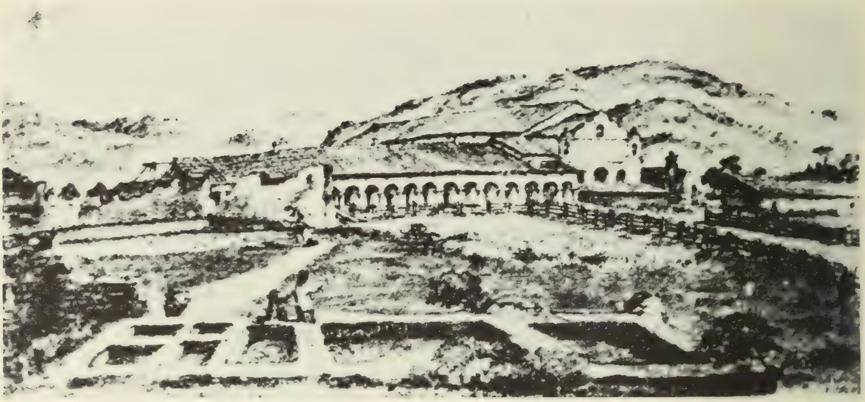


FIGURE 135. CHURCH, BUILDINGS AND RUINS OF THE MISSION OF SAN ANTONIO DE PADUA IN MONTEREY COUNTY. *Photo from the collection of The Society of California Pioneers.*

FIGURE 136. CASA DEL PASO DE ROBLES, THE OLD FARM BUILDINGS OF THE MISSION OF SAN MIGUEL, NEAR THE SHEEP-FARM OF JAMES BLACKBURN. *Photo from the collection of The Society of California Pioneers.*

FIGURE 137. SAN LUIS OBISPO. The lower (older) portion of the town and the Old Mission Buildings, as seen from the Mission Orchard. 1884. *Photo from the collection of the California Historical Society.*

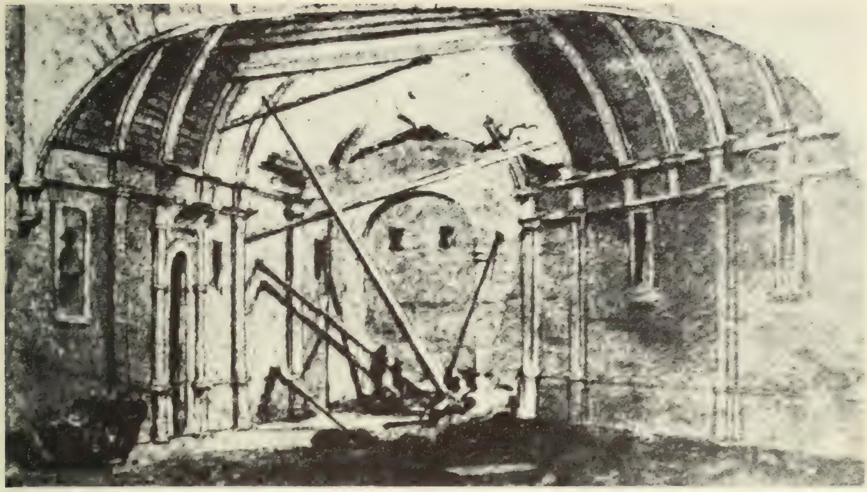


FIGURE 138. INTERIOR OF THE CHURCH. Mission San Carlos. *Photo from the collection of The Society of California Pioneers.*

FIGURE 139. REAR VIEW OF THE RUINS OF THE MISSION OF SAN CARLOS, FROM THE SEA-SIDE. *Photo from the collection of The Society of California Pioneers.*

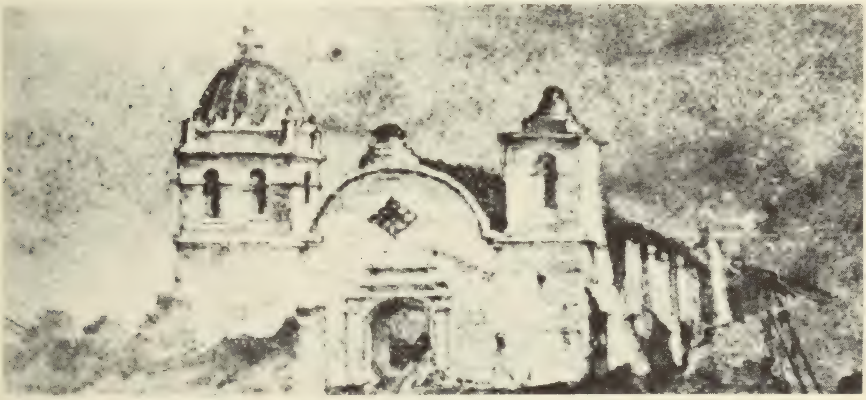


FIGURE 140. FRONT-VIEW OF THE CHURCH. Mission San Carlos. *Photo from the collection of The Society of California Pioneers.*

FIGURE 141. 1842. MONTEREY AT THE TIME OF THE ARRIVAL OF THE U. S. SQUADRON OF THE PACIFIC UNDER COM[D] TH. APR. C. JONES from the Original by G. J. Denny. *Photo from the collection of The Society of California Pioneers.*

FIGURE 142. MISSION OF SAN JUAN BAUTISTA, MONTEREY COUNTY. *Photo from the collection of The Society of California Pioneers.*

FIGURE 143. RUINS OF THE OLD MISSION OF SAN CARLOS, AT THE MOUTH OF THE RIVER CARMELO. *Photo from the collection of the California Historical Society.*

FIGURE 144. IMMIGRANT-ENCAMPMENT NEAR THE SOLEDAD MISSION-RUINS IN THE SALINAS VALLEY, PROPERTY SOBERANIS. Sketched June 26, 1873. *Photo from the collection of The Society of California Pioneers.*

FIGURE 145. RUINS OF THE MISSION NUESTRA SENORA DE LA SOLEDAD, IN THE SALINAS PLAINS. Property of the Soberanis (1873). *Photo from the collection of The Society of California Pioneers.*

FIGURE 146. EX-MISSION & CHURCH, SANTA CLARA . . . . . JESUIT COLLEGE. *Photo from the collection of The Society of California Pioneers.*

FIGURE 147. SKETCH OF THE CHURCH AND BUILDINGS OF THE MISSION OF SAN JOSE, UPPER CALIFORNIA, DRAWN AUGUST 16, 1866. *Photo from the collection of The Society of California Pioneers.*

FIGURE 148. A REMINISCENCE OF 1842. Bull fight at Mission Dolores, in celebration of the Patron Saint, San Francisco de Asis. Sketched 1876. *Photo from the collection of The Society of California Pioneers.*

FIGURE 149. RENOVATED CHAPEL AND RUINS OF THE BUILDINGS OF THE EX-MISSION SAN FRANCISCO SOLANO. Sonoma, June 1874. *Photo from the collection of The Society of California Pioneers.*

PAINTINGS BY EDWIN DEAKIN
1870-99

Figures 150 to 170, reproductions of twenty-one paintings of California missions by Edwin Deakin, are included herein by permission of Miss Dorothy Deakin, copyright owner. The original paintings are now in the collection of the Los Angeles County Museum, Exposition Park, Los Angeles; photographs for reproduction were furnished by the Museum, by courtesy of Mr. Richard O'Brien, Librarian, and Mr. R. M. Ariss, Curator.

Mr. Deakin, in the introduction to his *The Twenty-One Missions of California—Reproductions from Paintings by Edwin Deakin, Fourth Edition, Berkeley, 1901,* wrote:

"Study for the pictures, from which these reproductions are made, was begun in 1870, sketches and studies of the Mission Dolores being made in that year, of San Buenaventura and Santa Ines in 1875, and of those that still exist at different times between the years 1870 and 1899. Of the three Missions that are wholly destroyed, careful studies of the sites have been made." He makes acknowledgment "To Mr. Watkins for use of photographs of Mission San Jose, taken before the earthquake of 1868, and another of the corridor of Mission San Luis Obispo. . . . . To Mr. William J. Miller for full description of Mission San Rafael, now extinct." He obtained "the outlines of Santa Clara Mission . . . . . from a daguerreotype taken about 1855", and "the outlines of the Santa Cruz Mission, now extinct . . . . . from an old painting by L. Tousset." [See fig. 103.]

FIGURE 150. San Diego de Alcalá.

FIGURE 151. San Luís Rey de Francia.

FIGURE 152. San Juan Capistrano.

FIGURE 153. San Fernando Rey de España.

FIGURE 154. San Gabriel Arcángel.

FIGURE 155. San Buenaventura.

FIGURE 156. La Purisima Concepción.

FIGURE 157. Santa Bárbara.

FIGURE 158. Santa Ines.

FIGURE 159. San Luis Obispo de Tolosa.

FIGURE 160. San Miguel Arcángel.

FIGURE 161. San Antonio de Padua.

FIGURE 162. Nuestra Señora de la Soledad.

FIGURE 163. San Carlos Borromeo del Carmelo.

FIGURE 164. San Juan Bautista.

FIGURE 165. Santa Cruz.

FIGURE 166. Santa Clara de Asís.

FIGURE 167. San José de Guadalupe.

FIGURE 168. San Francisco de Asís.

FIGURE 169. San Rafael Arcángel.

FIGURE 170. San Francisco de Solano.

ETCHINGS AND SKETCHES BY HENRY CHAPMAN FORD
1880-88

Figures 171 to 194 by Henry Chapman Ford are reproduced from ". . . . . a series of twenty-four large etchings, comprising a complete and accurate representation of the old Franciscan Missions of California, with letter-press description and history, derived from Spanish records and personal investigation. . . . . The original studies were made in oil colors; the work covered several years of effort. Excursions were made . . . . . to each of these different missions, and no pains were spared in cases where a portion of them had been destroyed, to reproduce them in their original condition, from descriptions, drawings, and photographs. . . . . Some of them have fallen into ruin, particularly those situated remote from towns, as the San Fernando, San Diego, Purisima, Soledad, and San Carlos; also the San Juan Capistrano, and the first Purisima, both of which were destroyed by earthquake in 1812. The others are in a fair state of preservation . . . . ." *

* From a brochure in the collection of The Society of California Pioneers, *Etchings of the Franciscan Missions of California. With Outlines of History, Descriptions, etc. By Henry Chapman Ford. Twenty-four Etchings (mounted 17 x 22) with Letter Press (in portfolio). This Imperial Edition is limited to 250 copies only. The Etchings are on Japan and the letter press on antique paper. Price, $180.* [*ca. 1885.*]

Figures 195 to 207, etchings and sketches also by Mr. Ford, were not included in the collection; they are from various sources.

FIGURE 171. SAN DIEGO. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 172. SAN LUIS, REY DE FRANCIA. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 173. SAN JUAN CAPISTRANO. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 174. SAN GABRIEL. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 175. SAN FERNANDO. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 176. SAN BUENAVENTURA. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 177. SANTA BARBARA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 178. SANTA BARBARA (REAR VIEW). 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 179. SANTA YNEZ. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 180. LA PURISIMA CONCEPCION (OLD). 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 181. LA PURISIMA CONCEPCION. *Photo from the collection of The Society of California Pioneers.*

FIGURE 182. SAN LUIS OBISPO DE TOLOZO. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 183. SAN MIGUEL. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 184. SAN ANTONIO DE PADUA. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 185. NTRA. SRA. DE LA SOLEDAD. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 186. SAN JUAN BAUTISTA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 187. SAN CARLOS DE MONTEREY, OR CARMEL. 1883. *Photo from the collection of The Huntington Library.*

FIGURE 188. SAN CARLOS DE MONTEREY (IN 1834). 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 189. SANTA CRUZ. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 190. SANTA CLARA. *Photo from the collection of The Society of California Pioneers.*

FIGURE 191. SAN JOSE. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 192. DOLORES. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 193. SAN FRANCISCO DE SOLANO. 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 194. PALA. (MISSION STATION ATTACHED TO SAN LUIS REY). 1883. *Photo from the collection of The Society of California Pioneers.*

FIGURE 195. BLOCKHOUSE AT SANTA BARBARA, 1886. *Photo from the collection of The Huntington Library.*

FIGURE 196. SANTA MARGARITA ASISTENCIA. *Photo from the collection of The Huntington Library.*

FIGURE 197. GENERAL VIEW OF THE RUINS OF MISSION SAN FERNANDO REY. *Original sketch in the collection of Southwest Museum. Photo from the collection of The Huntington Library.*

FIGURE 198. PALA MISSION, SAN DIEGO COUNTY, JULY 5, 1880. *Original sketch in the collection of Southwest Museum. Photo from the collection of The Huntington Library.*

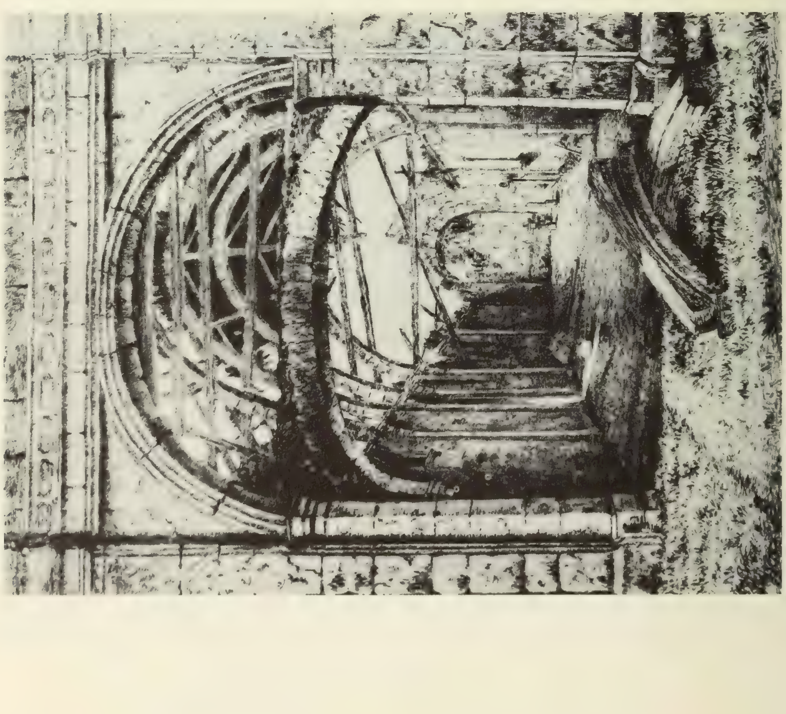


FIGURE 199. SAN CARLOS BORROMEO. (INTERIOR, 1888.) *Photo from the collection of The Society of California Pioneers.*

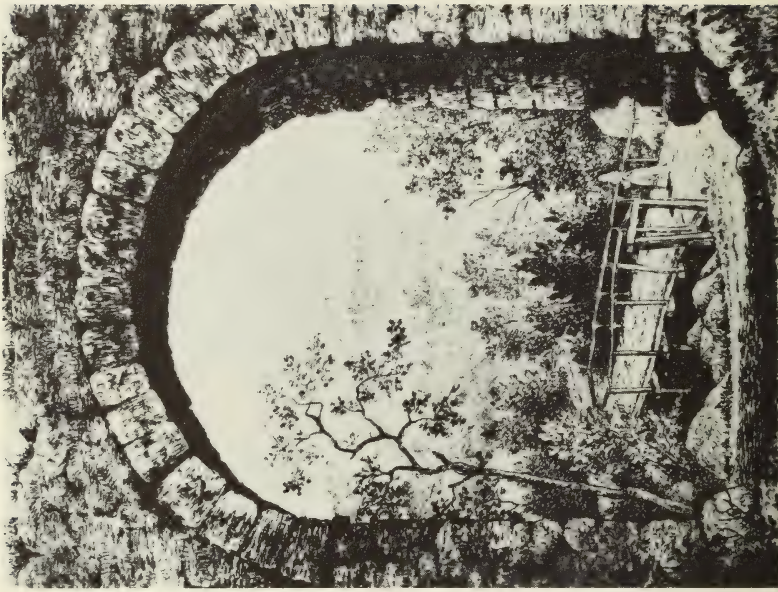


FIGURE 200. SANTA BARBARA MISSION (ARCH UNDER THE AQUEDUCT). 1880. *Photo from the collection of The Huntington Library.*

FIGURE 201. SANTA BARBARA MISSION, 1888. *Photo from the collection of The Society of California Pioneers.*

FIGURE 202. SANTA BARBARA MISSION. 1888. *Photo from the collection of Southwest Museum, Los Angeles.*

FIGURE 203. RUINS OF SAN BERNARDINO MISSION, CUCOMUNGA RANGE, 1880. *Original sketch in the collection of Southwest Museum. Photo from the collection of the California Historical Society.*

FIGURE 204. RUINS OF SAN BERNARDINO MISSION, 1881. *Original sketch in the collection of Southwest Museum. Photo from the collection of the California Historical Society.*

FIGURE 205. RUINS OF SAN BERNARDINO MISSION, JULY 8, 1880. *Original sketch in the collection of Southwest Museum. Photo from the collection of the California Historical Society.*

FIGURE 206. RUINS, SAN MARCOS MISSION, SANTA INEZ VALLEY, 1885. *Original sketch in the collection of Southwest Museum. Photo from the collection of the California Historical Society.*

FIGURE 207. SANTA BARBARA MISSION (INNER COURT). 1888. *Photo from the collection of Southwest Museum, Los Angeles.*

PAINTINGS BY ORIANA DAY
1882-83

Twenty-one oil paintings of the California missions (figs. 208 to 228) by Oriana Day are in the collection of the H. M. DeYoung Memorial Museum, Golden Gate Park, San Francisco, and are reproduced herein by permission of the Museum. Photographs are by Mary Rae Hill.

Figures 229 and 230, also from paintings by Mrs. Day, represent the plaza at Sonoma.

Oriana Day's mission paintings represent the buildings as she believed they originally existed, rather than in the state of decay or semi-destruction in which she observed many of them during the early eighties. Her pictures were based on her own observations, on older sketches and paintings, and on what she could glean from persons who had seen the originals in their prime.

FIGURE 208. SAN DIEGO DE ALCALÁ, 1769.

FIGURE 209. SAN CARLOS BORROMÉO, 1770.

FIGURE 210. SAN ANTONIO DE PADUA, 1771.

FIGURE 211. SAN GABRIEL ARCÁNGEL, 1771.

FIGURE 212. SAN LUIS OBISPO DE TOLOSA, 1772.

FIGURE 213. SAN FRANCISCO DE ASIS, 1776.

FIGURE 214. SAN JUAN CAPISTRANO, 1776.

FIGURE 215. SANTA CLARA, 1777.

FIGURE 216. SAN BUENAVENTURA, 1782.

FIGURE 217. SANTA BARBARA, 1786.

FIGURE 218. LA PURISIMA CONCEPCION, 1787. (VIEJA)

FIGURE 219. SANTA CRUZ, 1781.

FIGURE 220. NUESTRA SENORA DE LA SOLEDAD, 1791.

FIGURE 221. SAN JOSE, 1797.

FIGURE 222. SAN JUAN BAUTISTA, 1797.

FIGURE 223. SAN MIGUEL ARCÁNGEL, 1797.

FIGURE 224. SAN FERNANDO REY DE ESPANA, 1797.

FIGURE 225. SAN LUIS REY DE FRANCIA, 1798.

FIGURE 226. SANTA YNEZ, 1804.

FIGURE 227. SAN RAFAEL ARCÁNGEL, 1817.

FIGURE 228. SAN FRANCISCO SOLANO, 1823.

FIGURE 229. The Plaza at Sonoma. Painting in the collection at the Vallejo home, Sonoma. *Photo from the collection of The Huntington Library, San Marino.*

FIGURE 230. The Plaza at Sonoma, from a painting once in the collection of the Native Sons' Hall Association, San Francisco. *Photo from the collection of The Society of California Pioneers.*

FIGURE 231. STONE AND TILE, AT DOOR TO CHAPEL, MISSION SAN JUAN CAPISTRANO, 1905. *Photo from the collection of The Huntington Library.*

IN TRANSLATION
1798-1951

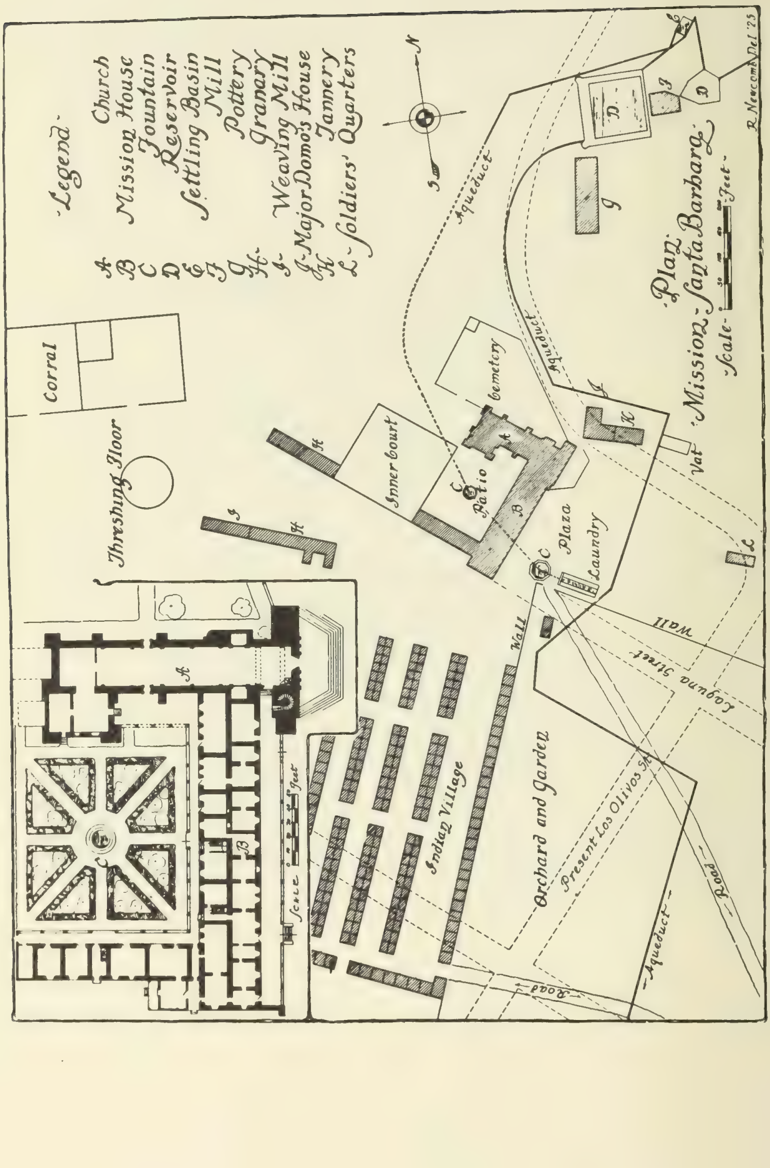


FIGURE 232. PLAN OF MISSION SANTA BARBARA. Reprinted from The Old Mission Churches and Historic Houses of California by Rexford Newcomb, J. B. Lippincott Co., 1925, by permission of Mr. Newcomb, copyright owner. Photo by Mary Rae Hill.

THE FRANCISCAN FATHERS

Translation by Geraldine E. Martino

Report on the spiritual and temporal affairs of the Mission of the Virgin and Martyr Santa Barbara, situated on the channel of the same name; from the 4th day of December of the year 1786, which was the day of dedication, to the 31st day of December 1787.

The Year 1787. On the 4th day of December of the year 1786, on which our Holy Mother the Church celebrates the feast of the Virgin and Martyr Santa Barbara, the Holy Cross was raised on the site of founding, and the mission dedicated to that Saint, Virgin, and Martyr; the site is that called El Pedragoso, and is distant about a quarter of a league from the presidio named for the aforementioned Saint. On the 15th day of the same month and year, the first Mass was celebrated in a shelter roofed with branches. The Reverend Father President Father Fermin Francisco de Lasuen gave the sermon, assisted by the Governor and a few soldiers who accompanied him. Because of the severity of the winter in this country, and because of the abundant and continuous rains, it was not possible to build, although some timber was cut, to take advantage of favorable weather for construction. The first ministers appointed by the Reverend Father President for this founding were the Reverend Fathers Antonio Paterna and Christoval Oramas, who have maintained this mission, and who make this report which follows. . . . .

Building. A house of poles, 16 varas * long and 5 wide, divided into two rooms, plastered, and roofed with grass, has been built as living quarters for the Fathers. Next to this, a room 6 varas long and 5 wide, with a grass-covered mud roof, serves as a kitchen. Item: a granary 21 varas long and 5 wide, built of sticks, plastered, and roofed with grass. Item: a house 12 varas long and 5 wide, built of poles, plastered, and roofed with grass; this serves to shelter the unmarried women and girls. Item: a chapel 14 varas long and 5 wide, built of poles and plastered, and roofed with grass. Item: a room 6 varas long and 5 wide was built, and roofed with mud and grass; this is used for the servants. Item: a room 10 varas long and 5 wide, built of poles and plastered, and roofed with mud and grass, serves as a carpenter shop, and to shelter the unmarried men and boys. Item: four rooms, one 8 varas long, two 6 varas long, the other 5 varas long; all 6 varas wide, with walls of adobe 1 vara thick. We have not been able to cover these from the rains. . . . . Fr. Antonio Paterna—Fr. Christoval Oramas.

Jan. 1, 1788 to June 30, 1788. Nothing has been built but a corral of upright timbers for the animals, because of the lack of food to maintain the Indians at the Mission. . . . . Fr. Antonio Paterna—Fr. Christoval Oramas.

* *League and Vara:* In the Spanish and Mexican days a "league" of land meant a square league. A league was 5,000 varas long, and the square league was 5,000 varas square. The vara was similar to our yard and is usually translated by that term, but they are not of the same length. Theoretically the vara measure on the cathedral in Burgos was the standard but in time its length in the Americas became different; in the late Mexican period the vara in California differed from the vara in Texas. In California the vara before 1846 was a very small fraction under 33 inches. The Americans in the forties accepted it as 33 inches. *J. N. Bowman and G. W. Hendry, in Spanish and Mexican Houses in the Nine Bay Counties,* ms., Bancroft Library, California State Library, 1942.

FIGURE 233. ". . . . . A SHELTER ROOFED WITH BRANCHES . . . . ." Interior of Santa Isabel, asistencia to Mission San Diego de Alcalá, as it appeared in 1902. *Photo from the collection of The Huntington Library.*

July 1, 1788 to Dec. 31, 1788. The four rooms mentioned in the earlier report have been roofed and covered with tile, and doors have been made for them. Item: the house for the unmarried women and girls has been covered with tile. In the same manner, the house for the single men, which is at present used as a granary, has also been roofed with tile. Item: a house 12 varas long and 5 wide has been built of poles and roofed with tile. Item: a room of adobe, roofed with tile, serves as a kitchen. The church has been enlarged a bit, and the addition is half adobe, and roofed with tile. . . . . Fr. Antonio Paterna—Fr. Christoval Oramas.

Jan. 1, 1789 to Dec. 31, 1789. First of all: a church 30 varas long and 6 wide has been built of adobe, roofed with tile, and provided with a door. Item: a granary 31 varas long and 7 wide, of adobe and roofed with tile. Item: close to this, a room 12 varas long and 7 wide, of adobe and roofed with tile; this is for the unmarried women and girls. Item: two rooms 5 varas long and 4½ wide, of adobe and roofed with tile, serve one as a chicken house, the other as a jail. Item: a room 9 varas long and 5 wide, built of poles and roofed with tile; it is for storing the saddles and harnesses and other equipment for the muleteers. . . . . The above constitutes &c. . . . . Fr. Antonio Paterna.

Jan. 1, 1790 to Dec. 31, 1790. First of all: two dwellings were built for the Padres Ministros; they are 10 varas long and 6 wide, and each is divided into a reception room 6 varas long and a bedroom. These four rooms, which have doors and windows, are roofed with tile. Item: a corridor 60 varas long and 6 wide, divided into eight rooms—refectory, kitchen, privy-house, tool shed; door; wood shed, jail, mill, and house for the women; the whole is roofed with tile, and has doors and windows. Item: a room 12 varas long and 7 wide, roofed with tile, for a granary. Item: a pozolera * covered with tile. All of these rooms

* The place where the *pozole* (a thick soup of meal, vegetable, and meat) was cooked. *Fr. Zephyrin Engelhardt,* in *Santa Barbara Mission, 1923.*

FIGURE 234. "FIRST OF ALL: A CHURCH . . . . . HAS BEEN BUILT OF ADOBE . . . . ." *Reprinted from "Santa Barbara Mission", by Fr. Zephyrin Engelhardt, O.F.M., by courtesy of Fr. Maynard Geiger, Archivist, Old Mission, Santa Barbara.*

are of adobe and plastered with mortar. . . . . The above constitute the things built at Mission Santa Barbara to the 31st day of December of 1790. . . . . Fr. Antonio Paterna—Fr. Jose de Miguel.

Jan. 1, 1791 to Dec. 31, 1791. Four rooms have been built. One, 10 varas long and 6 wide, serves as a guard house for the soldiers. The other three serve as storerooms for farm implements and carpenter tools. All are made of adobe and roofed with tile. . . . . Mission of Santa Barbara, 31st of December of the year 1791. . . . . Fr. Antonio Paterna—Fr. Jose de Miguel.

Jan. 1, 1792 to Dec. 31, 1792. Two corrals have been constructed, one for cattle, the other for sheep, both of stone. The first is 90 varas long and 75 wide; the second is 75 varas wide and 50 long. . . . . Mission of Santa Barbara, 31st of December of 1792. . . . . Fr. Antonio Paterna—Fr. Jose de Miguel.

Dec. 31, 1793. A church of adobe 45 varas long and 9¼ wide, and a sacristy of adobe 9¼ varas long and 5 wide have been built. Both have been roofed with tile and plastered with mortar inside and out. The portico at the front of the church is of brick, and is roofed with brick and tile. . . . . Mission of Santa Barbara, 31st of December of 1793. . . . . Fr. Estevan Tapis—Fr. Jose de Miguel.

Dec. 31, 1794. A granary 26 varas long and 7 wide was built of adobe; a weaving room, 18 varas long and 7 wide, also of adobe, and with a patio of adobe 10 varas wide and 18 long, was also erected. The foundation of these buildings is of stone and mortar. The whole is roofed with tile, and the crevices in the walls are for the most part filled in with small stones and mortar, and then plastered with mortar on the outside. Item: an adobe wall was built around the cemetery, which was 45 varas long and 16 wide; the top of the wall was cov-

FIGURE 235. CLAY PIPE FROM MISSION SANTA BARBARA. This pipe was made about 1790, and was in use until the late nineteen-thirties. Pipe lines were joined by cement made of finely ground mussel and clam shells, or, less commonly, with tar from seeps not far from the mission. *Photo by Rod T. Antrim, courtesy of Old Mission, Santa Barbara, and Pacific Coast Clay Products Institute.*

ered with tile. Item: a corral of adobes covered with tile was erected for the sheep; it is 62 varas long and 62 varas wide, and 3 varas high. . . . . Mission of Santa Barbara, 31st of December of 1794. . . . . Fr. Estevan Tapis—Fr. Jose de Miguel.

Dec. 31, 1795. The roof beams and supports of poplar and alder, which had rotted, were replaced with beams and supports of pine on 2½ sides of the tile-covered mission square. To the living quarters of the missionary Fathers four rooms were added, which are 25 varas long and 3 wide, with three partition walls to divide them. Two serve as bedrooms, and the other two as study rooms. These works are for the greater part of mortar, stone, and brick. . . . . Mission of Santa Barbara, 31st of December of 1795. . . . . Fr. Estevan Tapis—Fr. Jose de Miguel.

Dec. 31, 1796. In six rooms of the mission the roof beams and supports of poplar and alder were removed, because they were decayed and therefore dangerous; and in their place beams and supports of pine were substituted. Now all the buildings of the mission have pine wood throughout. A corridor 3 varas wide and 45 long, with pillars of brick and mortar and a tile roof, was made to protect the wall facing the presidio against the rain. Another corridor 3 varas wide and 18 long, with pillars of adobe and a tile roof, was built in the patio where the weaving is done. Two rooms of adobe, 3 varas wide and 6 long, were also

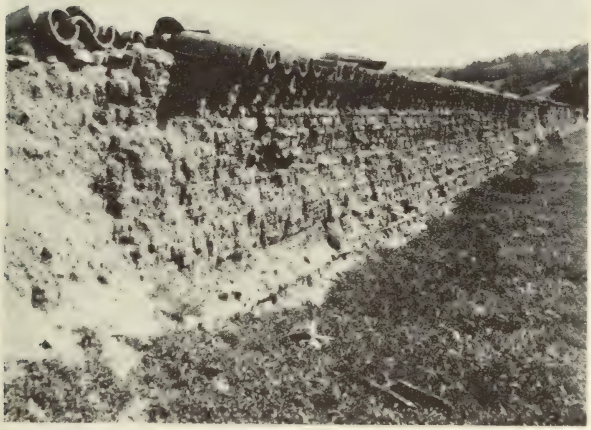


FIGURE 236. "AN ADOBE WALL WAS BUILT . . . . . COVERED WITH TILE . . . . ." Tile-covered adobe wall at Mission San Antonio de Padua, as it appeared in 1906. *Photo by G. W. James, from the collection of The Huntington Library.*

built at the two ends of the corridor. . . . . Mission of Santa Barbara, 31st of December of 1796. . . . . Fr. Estevan Tapis—Fr. Jose de Miguel.

Dec. 31, 1797. Three granaries, of 25 varas each, have been built; a room of 6 varas, which is the entrance to two of the granaries, a room of 10 varas for the calves, one of 9 varas for the smithy, and another of the same size for a chicken house, also have been constructed. All these rooms have their doors and locks. They are 6 varas wide, of adobe, plastered on the outside with mortar, and roofed with tile; and though they form a separate square, it is entered through the old part of the mission. . . . . Mission of Santa Barbara, 31st of December 1797. . . . . Fr. Estevan Tapis—Fr. Jose de Miguel.

Dec. 31, 1798. Nineteen rooms of adobe have been built for as many families of neophytes. Each one is 4 varas wide and 6½ long, and each one has its door and window that can be closed. All are plastered on the outside with mortar, and on the inside they are whitened with milk of lime; they are roofed with tile. A wall 3 varas high, topped with tile, encloses an area 2100 varas in circumference, which contains a kitchen garden, vineyard, and fruit trees. . . . . Mission of Santa Barbara, 31st of December, 1798. . . . . Fr. Estevan Tapis—Fr. Juan Cortes.

Dec. 31, 1799. A granary of adobe was built, which is 45 varas long and 6½ wide, roofed with tile, and plastered both inside and out with mortar. . . . . Mission of Santa Barbara, 31st of December of 1799. . . . . Fr. Estevan Tapis—Fr. Juan Cortes.

*Dec. 31, 1800.** Thirty-one houses of adobe have been built as habitations for as many families of neophytes; these are similar in every respect to the twenty

* In October of 1800, Fathers Tapis and Cortes of Mission Santa Barbara wrote to Fr. Presidente Fermin Francisco de Lasuen, defending their management of the mission, in reply to the criticism voiced by Comandante Felipe Goycoechea, who had expressed his opinion of mission affairs in answers to fifteen questions put to him by Governor Borica. The Fathers set forth their defense in a *Reply of the Ministers of Santa Barbara to the Answers that Comandante*

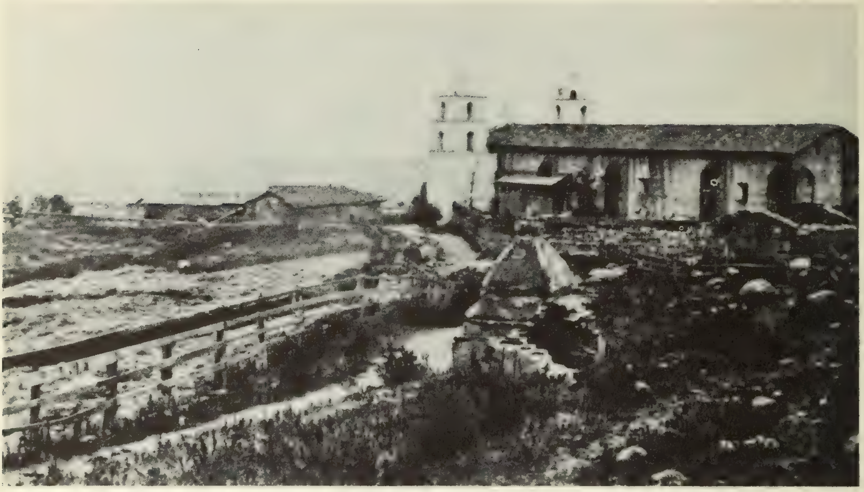


FIGURE 237. SANTA BARBARA MISSION ABOUT 1875. *Photo from the collection of The Huntington Library.*

FIGURE 238. ". . . . . A HOUSE . . . . . WAS BUILT FOR THE MAYORDOMO . . . . ." The Mayordomo's house and the tanning vats are in the central foreground of this photo, which was taken in 1875. See also J and K, fig. 232. *Photo by Watkins (new series), from the collection of The Huntington Library.*

already built. All of them are roofed with tile, plastered on the outside with mortar, and whitened on the inside with milk of lime. They have their doors and windows, and are so placed as to form a street. In addition, corridors with pillars of brick and mortar have been built along three walls of the mission

---

Goycoechea Gave to the Fifteen Questions Regarding Abuses by the Aforesaid Missionaries, and in their comments on Goycoechea's answer to question 9 presented the following data on construction work done by the neophytes:

"Question 9: How many hours are the Indians required to work? Are the pregnant Indian women, nursing mothers, and old women and children obliged to work?

". . . . So that it may be understood what the Comandante considers such hard work, we will explain clearly and distinctly the duties imposed. The women are given only the task of grinding. Each one grinds two *almudes* of wheat per day for *atole.* When it is for bread, eight, and sometimes nine women grind seven *almudes* of soaked wheat. The men are given the task of making adobes: 360 adobes two-thirds (of a vara) long and 1 (vara) wide; nine Indians work together, making 40 adobes each. The earth is soft, and the water nearby. Those who work at this task never work after eleven, never work on Saturday, and oftentimes do not work on Friday, because they complete their assigned task during the early part of the week. Those who make tiles also have their duties assigned. Sixteen young men are selected, and sometimes as many more middle-aged men, or recruits from the *rancheria;* all these people, with two women who carry them sand and cow dung, make 500 tiles a day. They have the troughs of clay nearby, and these are always full. These Indians finish working before eleven; nevertheless, they always speed up their work, so that they have Saturday free to walk about or rest. . . . . Now we will compare the tasks of these workers in adobe and tile with those of the Presidio. In 1795 the Commandante of the Presidio, Don Felipe Goycoechea, asked for ten Indians to make tile. We selected ten of the most skillful and diligent for the work, most of whom are still living. After laboring four days at the Presidio, on Thursday they complained that they could not endure the work, and that their hands and arms were very sore. They were asked how much work they did per day. They replied, 500 tiles; which meant that they had to dig the clay and throw it in the troughs; that they had to add cow dung, and water from a well 15 varas deep, or from a lake some distance away; that they had to carry the lake water from the beach, an eighth of a league from where they made the tile; that they had to mold the clay; and finally, that they alone, between morning and night, had to produce 500 well-made tiles, for the soldier Olivas stood over them to see that the work was done. Such arduous work seemed incredible, and it was feared that this was some falsehood concocted by the Indians. Nevertheless, they were urged to continue, and on Friday they repeated their complaint with more insistence, adding that on this day they had to make 525 tiles. At that time they were told to have patience the following day, and that we would see about relieving them of such hard work. That same Saturday the Comandante came to the mission, and was informed of the Indians' complaints; he replied that this was the amount of work formerly done by the soldiers. We then proposed that ten chosen soldiers be placed with the same ten Indians from morning to night, to see who made the most tiles; he would not agree to this, but said that the Indians need not come any more, for there was now sufficient tile. As for the daily task of the Indian who makes adobes: Señor Arrillaga, then provisional governor of this peninsula, declared in 1793 that the number should be set at 50 per day. Last year Don Jose Maria Ortega, then a Sargeant, asked for peons from the mission to make adobes and to build a house outside the presidio. These were granted, with the stipulation that the daily task should be 50 adobes per individual and no more, in accordance with the declaration of the aforementioned Señor Arrillaga. He agreed to the condition, but contrived to have made a mould three-quarters of a vara long and half a vara wide, and also higher in proportion that the normal ones, which have been two-thirds long and one wide. Water had to be drawn from a well more than 12 varas deep. From the two tasks that we have just described, any impartial person may judge which labor deserves the most compassion—that borne by the Indians at the mission, or that borne by the Indians at the presidio. . . . . All of the women who are considered useful help carry adobes, when the cart assigned for the purpose at the start of construction work is not sufficient; however, the cart is often all that is needed, for the adobes are always made near the buildings. These same women help carry the brick and tile, and very infrequently stones—but only small ones—for leveling the foundations. Carrying the rest of the building materials is the work of the drovers with their oxen and the muleteers with their mules. Of the little children over nine years of age, some comb the wool in the looms and hand the shuttle and quill to the weavers; others look after the tile and brick during the day, so the animals do not step on it; still others frighten away the birds; and the rest amuse themselves with their childish games."

FIGURE 239. TILE ROOF ON BUILDING AT MISSION SAN ANTONIO DE PADUA, AS IT APPEARED IN JUNE 1902. *Photo from the collection of the California Historical Society.* Newcomb, in *The Old Mission Churches and Historic Houses of California,* describes the making of tile as follows: "These tiles were almost semicircular in cross-section, about 22″ long, and tapered from a diameter of 12″ at the large end to a diameter of 8″ at the small end. The padres followed the primitive custom of kneading or working the clay in pits under the hoofs of animals, then giving it time to ferment properly. The tiles were fashioned by making a pat of clay the correct thickness upon a flat board and then turning it over a half-round tapering 'mould' of wood which was well sanded to prevent the clay from adhering. After the cake had been pressed around the 'mould' it was trimmed along the edges, dried in the sun, and finally baked or fired in small kilns. Naturally the quality of the mission tiles varied with the clays of the different localities and with the processes of manufacture. Some specimens are very soft and irregular, while others appear as fine examples of craftsmanship."

square; they are roofed with tile and paved with brick. . . . . Mission of Santa Barbara, 31st of December of 1800. . . . . Fr. Estevan Tapis—Fr. Juan Cortés.

1801. Thirty-one houses of adobe have been built as dwellings for as many families of neophytes; these are similar in all respects to the fifty-one built in the 2 years preceding. In addition, a house 21 varas long and 6 wide was constructed, and its corridor; it is divided into a bedroom, reception room, kitchen, and chicken house, roofed with tile, and plastered with mortar. . . . . Mission of Santa Barbara, 31st of December 1801. . . . . Fr. Estevan Tapis—Fr. Juan Cortes.

1802. Thirty-one houses of adobe have been built as habitations for as many families of neophytes; these are in every respect similar to the eighty-two built in the preceding 3 years. They are surrounded on three sides by a mud wall 3 varas high, within which is sufficient space for the houses which are yet to be built. A mud-wall and adobe room 20 varas long and 6 wide was also built; and 5 troughs of brick and mortar for tanning hides. Next to this, a house 18 varas long and 6 wide, complete with corridor, was built for the Mayordomo; it is divided into a kitchen, reception room, and bedroom. Finally, five mud-wall and adobe rooms were constructed, to meet the various needs of the mission; these were in all 40 varas long and 6 wide. . . . . Mission of Santa Barbara, 31st of December, 1802. . . . . Fr. Estevan Tapis—Fr. Juan Cortes.

FIGURE 240. "A RESERVOIR FOR STORING WATER WAS CONSTRUCTED, ALL OF STONE AND MORTAR . . . . ." This photograph, taken March 12, 1898, shows part of the Santa Barbara water system. In the extreme lower right-hand corner is the settling basin shown also in fig. 241; at the extreme left is the upper reservoir, and just below it the mill shown in fig. 242; the lower reservoir is surrounded by the wooden fence. See *D, E,* and *F* on fig. 232. Newcomb, in *The Old Mission Churches and Historic Houses of California,* describes the water-system as follows: "The water-supply was obtained by the damming of Pedragosa Creek some two miles above the mission [see fig. 245]. From the dam the water was conducted, by means of a stone aqueduct, to a settling-basin northeast of the mission church. This aqueduct was built in such a way as to follow the contour of the hills and canyons, and so well constructed that, after a hundred years, it remains, where not destroyed by man, in excellent condition. From the settling-basin, or filter, the water was led into the great stone reservoir, 110 feet square and seven feet deep, which was completed in 1806. . . . . Upon the hill above the reservoir . . . . . was subsequently built a second small reservoir, which was also supplied from the dam. Between these two reservoirs was built the water-power grist mill where Padre Ripoll ground his grain. The upper reservoir was provided with wooden sluice-gates by means of which the water to turn the millwheel could be controlled. . . . . From the settling-basin, constructed to purify the domestic supply, an aqueduct formerly conducted the water to be used for household purposes to the rear of the mission. From here it was distributed to the fountains. This aqueduct consisted of a water-way four inches in diameter carried atop a heavy stone wall, which, crossing the road that leads to the bridge, was pierced at this point by a pretty arch that remained in place until about 1880." *Photo from the collection of Southwest Museum, Los Angeles.*

FIGURE 241. THE SETTLING-BASIN, OR WATER-FILTER HOUSE AS IT APPEARED IN 1898. *Photo from the collection of the California Historical Society.*

1803. Forty-eight houses of adobe have been built as habitations for as many families of neophytes; these were similar in all ways to the 113 built in the preceding years. In addition, a church 22 varas long and 9 wide, including the walls, was constructed on a rancheria 2 leagues distant from the mission; it is called San Miguel. . . . . Mission of Santa Barbara, 31st of December of 1803. . . . . Fr. Estevan Tapis—Fr. Juan Cortès.

1804. Thirty-seven houses of adobe have been built to house as many families of neophytes; these are similar in every respect to the 161 built in the preceding years; also, a large partially covered patio has been made, which the noephytes use for various purposes. . . . . Mission of Santa Barbara, December 31 of the year of the Lord 1804. . . . . Fr. Juan Cortes—Fr. Marcos Amestoy.

1805. Two large rooms were built for granaries and one of the same size for wood; 36 houses were built for the Indians, with doors and windows, and similar in all respects to those of the previous years, in all numbering 234. . . . . Mission of Santa Barbara, December 31 of 1805. . . . . Fr. Marcos Amestoy—Fr. Marcos Antonio de Vitoria.

1806. A reservoir for storing water was constructed, all of stone and mortar; it is 40 varas square and 2½ high. . . . . Mission of Santa Barbara, December 31 of 1806. . . . . Fr. Marcos Amestoy—Fr. Jose Antonio Urresti.

1807. Eighteen houses were built on the rancheria, similar in all respects to those previously constructed, in all totaling 252. Four houses were built with their guard rooms; also a dam of rough stone and mortar. . . . . Mission of Santa Barbara, December 31 of 1807. . . . . Fr. Jose Antonio Urresti—Fr. Marcos Amestoy.

1808. A fountain and its wash trough have been constructed for the benefit of humanity, and a house for pottery making. The unfinished work will be

FIGURE 242. THE MILL, AS IT APPEARED IN 1898. *Photo from the collection of the California Historical Society.*

FIGURE 243. PART OF THE STONE AQUEDUCT, AS IT APPEARED IN 1898. Photo from the collection of the *California Historical Society.*

FIGURE 244. "A FOUNTAIN AND ITS WASH TROUGH HAVE BEEN CONSTRUCTED FOR THE BENEFIT OF HUMANITY . . . . ." *Photo by Helen S. Giffen, from the collection of The Society of California Pioneers.*

FIGURE 245. ". . . . . A DAM OF ROUGH STONE AND MORTAR . . . . ." The Santa Barbara Mission dam. *Photo by courtesy of Anderson Photo Service, Santa Barbara.*

FIGURE 246. SANTA BARBARA MISSION. ". . . . . IT IS OF HEWN STONE AND MORTAR, WITH VERY STRONG WALLS, HEAVY BUTTRESSES, AND TOWER TWO STORIES HIGH . . . ." *Photo from the collection of Southwest Museum, Los Angeles.*

reported next year. . . . . Mission of Santa Barbara, December 31 of 1808. . . . . Fr. Marcos Amestoy—Fr. Luis Gil de Taboada.

1809. That part of the habitation of the Padres Ministros that looks toward the sea has been added to, with a wall of lime and stone, and a flat roof made to be walked on. . . . . Mission of Santa Barbara, December 31 of 1809. . . . . Fr. Luis Gil de Taboada—Fr. Marcos Amestoy.

1810. That which was reported last year is being continued. . . . . Mission of Santa Barbara December 31 of 1810. . . . . Fr. N[omen]—Fr. N[omen].

1811. The habitation of the Padres Ministros, mentioned in 1809, has been completed, with a corridor of stone arches. The frontispiece of the Holy Church has been started, and will be reported on when it is completed. . . . . Mission of Santa Barbara, December 31 of 1811. . . . . Fr. Luis Gil and Fr. Marcos Amestoy.

1812. In the terrible earthquakes of December 21st and the days following, the mission was considerably damaged, necessitating a careful inspection and somewhat extensive repairs. The Holy Church, particularly, should be rebuilt, when permission is obtained from the government; for there would be little difference in the amount of labor required to repair it, and the amount of labor required to rebuild it; and, comparing the small satisfaction that repaired walls would give us with the security provided by new, thick ones of lime and stone, on a solid foundation, reasons for the latter outweigh the former. . . . . Mission of Santa Barbara, December 31 of 1812. . . . . Fr. Luis Gil and Fr. Marcos Amestoy.

1813. All is the same as in previous years. . . . . Fr. Ramon Olbès—Fr. Marcos Amestoy.

FIGURE 247. "THE STATUE OF THE PATRONESS, SANTA BARBARA, WAS PLACED IN A NICHE IN THE FRONTISPIECE, WHICH APPEARS TO BE SUPPORTED BY SIX COLUMNS; AND IN THE CORNERS OF THE TRIANGLE WERE PLACED THE THREE VIRTUES, FAITH, HOPE, AND CHARITY . . . . ." In 1898, when this photograph was taken, the figure at the apex of the triangle had already been destroyed; the others were broken by the earthquake of 1925. *Photo from the collection of The Huntington Library.*

1814. Everything on the rancheria destroyed by quakes and rains has been rebuilt. . . . . Mission of Santa Barbara, December 31 of 1814. . . . . Fr. Luis Gil de Taboada—Fr. Ramon Olbès.

1815. Things remain the same as in previous years; what has deteriorated from use and the passage of time are being repaired and replaced. Mission of Santa Barbara, 31st of December of 1815. . . . . Fr. Ramon Olbès—Fr. Antonio Ripoll.

1816. The same things remain as in previous years, and those things that have been consumed by use and by time are being repaired and replaced. . . . . Mission of Santa Barbara, December 31 of 1816. . . . . Fr. Francisco Suñer—Fr. Antonio Ripoll.

1817. The same things remain from previous years. Twenty harnesses have been added, and various tools for carpentry; and the things that use and time have consumed are being replaced and repaired. A wing of adobe has been built,

which contains a granary, a room for the calves, and a room for tools and implements of the field, which have for some years been deteriorating with age; also, the flat roof on half the principal house was remodeled, and the decayed wood replaced. . . . . Fr. Francisco Suñer—Fr. Antonio Ripoll.

1818. The same things remain as in previous years, and those things that have been consumed by use and time are being repaired and replaced. . . . . Mission of Santa Barbara, 31st of December of 1818. . . . . Fr. Francisco Suñer—Fr. Antonio Ripoll.

1819. The same things remain as in previous years, and those things that have been consumed by use and time are being repaired and replaced. . . . . Mission of Santa Barbara, 31st of December of 1819. . . . . Fr. Francisco Suñer—Fr. Antonio Ripoll.

1820. Church and Sacristy. The present church of this mission, begun in 1815, was finished this year, and its benediction was celebrated the 10th of September this same year. It is of hewn stone and mortar, with very strong walls, heavy buttresses, and tower two stories high, holding six bells, three of them hand bells. It has a plastered ceiling with paintings, and marble columns and altar tables in the Roman style, of which there are three, including the main altar; and in one of these is a suitable pulpit. The statue of the patroness, Santa Barbara, was placed in a niche in the frontispiece, which appears to be supported by six columns; and in the corners of the triangle were placed the three virtues, Faith, Hope, and Charity; these four figures are of carved stone, and painted in oil. The floor of the church is of burnished bitumen, which makes it very neatly finished. With this, and the various embellishments that have been placed thus in the church, as well as in the sacristy, it is very agreeable to the sight, strong, and elegant. . . . .

Building. The same things remain as in previous years, and those things that have been consumed by use and time are being repaired and replaced. . . . . Mission of Santa Barbara, 31st of December of 1820. . . . . Fr. Francisco Suñer—Fr. Antonio Ripoll.

FIGURE 248. CARMEL MISSION. *Photo from the collection of the California State Library.*

JEAN-FRANCOIS GALAUP DE LA PÉROUSE *

. . . . . On the 7th the fog was still thicker than on the day preceding; it cleared up, however, towards noon and we saw the tops of the mountains to the eastward at a very considerable distance. As our course was to the southward, it is evident, that, from the 42d degree, the coast begins to run away to the eastward. Our latitude observed at noon, was 40° 48′ 30″ north; our longitude, according to the time-keeper, was 126° 59′ 45″ west. I continued my course to near the land, from which, at night-fall, I was only four leagues distant. We there perceived a volcano on the top of a mountain, which bore east of us; its flame was very lively, but a thick fog soon deprived us of this sight; it became necessary to gain an offing. Being apprehensive, that, by following a course parallel to the coast, I might fall in with some rock or island at no great distance from the continent, I tacked, and stood off shore. The fog was very thick. . . . .

. . . . . At three o'clock in the afternoon ⟦September 14, 1786⟧ we got sight of Fort Monterey, and two three-masted vessels which lay in the road. . . . .

It is not a little remarkable, that during the whole of this long run, in the midst of the thickest fogs, the Astrolabe always sailed within hail of my ship, and was never farther from her, till I gave orders to M. de Langle to reconnoitre the entrance at Monterey. . . . .

The parish church is very neat, although covered with straw; it is dedicated to Saint Charles, and ornamented with pretty good paintings, copied from Italian originals. . . . .

. . . . . The missionary's house . . . . . is in front of the church, as are also the different storehouses. On the right stands the Indian village, consisting of about fifty cabins, which serve as dwelling places to seven hundred and forty persons of both sexes, comprising their children, which compose the mission of Saint Charles, or of Monterey.

These cabins are the most miserable that are to be met with among any people; they are round, six feet in diameter, by four in height; some stakes, of the size of an arm, fixed in the earth, and which approach each other in an arch at the top, compose the timber-work of it; eight or ten bundles of straw, very ill arranged over these stakes, defend the inhabitants, well or ill, from the rain and wind; and more than half of this cabin remains open when the weather is fine; their only precaution is to have each of them two or three bundles of straw at hand by way of reserve.

All the exhortations of the missionaries have never been able to procure a change of this general architecture of the two Californias; the Indians say, that they like plenty of air, that it is convenient to set fire to their houses when they are devoured in them by too great a quantity of fleas, and that they can build another in less than two hours. The independent Indians, who as hunters so frequently change their places of abode, have a stronger motive.

---

* From *A Voyage Round the World, in the Years 1785, 1786, 1787, and 1788, by J. F. G. de la Pérouse: Published Conformably to the Decree of the National Assembly, of the 22d of April, 1791, and Edited by M. L. A. Milet-Mureau, Brigadier General in the Corps of Engineers, Director of Fortifications, Ex-Constituent, and Member of Several Literary Societies at Paris. In Three Volumes. Translated from the French. London: Printed for J. Johnson, St. Paul's Church Yard. 1798.*

G. H. VON LANGSDORFF *

The situation of the establishment [Mission San Jose] is admirably chosen, and according to the universal opinion, this mission will in a few years be the richest and best in New California. The only disadvantage is, that there are no large trees very near. . . . . To compensate this disadvantage, there are in the neighborhood of the mission chalk-hills, and excellent brick-earth, so that most of their buildings are of brick. . . . .

Father Pedro, who shewed me about every where, proposed, when we had visited all that he thought worthy of observation, to go and see the Indians preparing for their dance. I accepted his proposal with delight, and he led me to a small stream, by the side of which the dancers were assembled, extremely busy in smearing their bodies over with charcoal-dust, red clay, and chalk. One was ornamenting his breast, another his belly, another his thighs, and another his back, with regular figures of various kinds. Some were ornamenting their otherwise naked bodies all over with down feathers, which gave them rather the appearance of belonging to the monkey species than of being men. Their heads, ears, and necks, were set off with a great variety of ornaments, but the bodies, except a covering about the waist, were naked. The women were at the same time performing the offices of the toilet in their houses; they were all, consistently with the laws of decorum, dressed; their faces and necks only were painted, and they wore also a profusion of ornaments of shells, feathers, and beads.

---

* From *Voyages and Travels in Various Parts of the World, During the Years 1803, 1804, 1805, 1806, and 1807. By G. H. von Langsdorff, Aulic Counsellor to His Majesty the Emperor of Russia, Consul-General at the Brazils, Knight of the Order of St. Anne, and Member of Various Academies and Learned Societies. Part II, Containing the Voyage to the Aleutian Islands and North-West Coast of America, and Return by Land over the North-East Parts of Asia, Through Siberia, to Petersburgh. Illustrated by Engravings from Original Drawings. London: Printed for Henry Colburn, English and Foreign Public Library, Conduit-Street, Hanover-Square; and Sold by George Goldie, Edinburgh; and John Cumming, Dublin. 1814.* Original drawings were by Wilhelm Gottlief Tilesius von Tilenau.

FIGURE 249. BRICK, TILE, AND ADOBE AT MISSION SAN ANTONIO DE PADUA, 1903.
Photo from the collection of The Huntington Library.

Visitors From the Rurick *

OTTO VON KOTZEBUE

This afternoon, accompanied by all our gentlemen, I took a walk into the Presidio ⟦San Francisco⟧, where we were received at the gate by the commandant, Don Louis d'Arguello, and saluted with eight guns, and then conducted to his residence. I found the Presidio as described by Vancouver; the garrison consists of a company of cavalry, of which the commandant is chief, and has only one officer of the artillery under his command.

The 4th, at eight o'clock in the morning, we all rowed to shore, and went into the Presidio to ride to the Mission, according to our promise, in company with the commandant. . . . . The weather was extremely fine, and an hour's ride brought us to our journey's end, though above half of the road was sandy and mountainous. Only a few small shrubs here and there diversified the barren hills; and it was not till we arrived in the neighbourhood of the Mission, that we met with a pleasant country and recognized the luxuriant scenery of California. After passing through a street inhabited by Indians, which is the name given by the Spaniards here to the savage tribes, we stopped before a large building, adjoining the church, the residence of the missionaries, and were received by five priests, of whom three belonged to this Mission, and the two others had come from St. Clara to be present at the celebration of the festival ⟦of St. Francis⟧; they conducted us to a large, dirty room, plainly furnished, where we were received with much respect. Precisely at ten we entered the church, which is spacious, built of stone, and handsomely fitted up, where we already found several hundred half-naked Indians kneeling. . . . . After dinner they showed us the habitations of the Indians, consisting of long, low houses, built of bricks, and forming several streets. The uncleanliness in these barracks baffles description, and this is perhaps the cause of the great mortality; for of a 1000 Indians at St. Francisco, 300 die every year. The Indian girls, of whom 400 are in the mission, live separate from the men, likewise in such barracks: both sexes are obliged to labour hard.

ADELBERT VON CHAMISSO

. . . . . The accounts of La Peyrouse and Vancouver . . . we found very correct. Since their time there has been but little change in California. A fort, erected in a good situation, guards the harbour of San Francisco. The Presidio is new built with stone, and covered with tiles. The building of the chapel has not been begun. In the missions they build in the same manner, and the barracks of the Indians at San Francisco are of similar construction. An artillerist has erected mills in the missions, worked by horses; but they are now for the most part out of order, and cannot be repaired. At San Francisco is a stone which a horse turns without mechanism over another stone, the only mill in order. The Indian women rub the corn between two stones for immediate use. A windmill of the Russian American Company's settlement creates astonishment, but does not find imitators. Some years ago, when artizans were brought here at great expense to teach the necessary arts, the Indians profited more by their instructions than the *gente rational* (rational people) as the Spaniards call themselves.

---

* From *A Voyage of Discovery into the South Sea and Beering's Straits, for the Purpose of Exploring a North-East Passage, Undertaken in the Years 1815-1818, at the Expense of His Highness The Chancellor of the Empire, Count Romazoff, in the Ship Rurick, Under the Command of the Lieutenant in the Russian Imperial Navy, Otto von Kotzebue. Illustrated With Numerous Plates and Maps. In Three Volumes. London: Printed for Longman, Hurst, Rees, Orme, and Brown, Paternoster-Row. 1821.*

A. DUHAUT-CILLY *

The 28th, we saw at the same time the islands forming the channel, called Santa Bárbara, and Point Conception. This point, beyond which the coast takes an easterly direction, is very remarkable from its form. Appearing like a wedge, it rises from the sea; then falling toward the interior, after describing a long trail, it ascends again gently to the tops of the mountains.

As soon as we had passed this cape, the sea, before very much disquieted, became fair and smooth; but the breeze was light, and we advanced but slowly, having on our right the islands of San Miguel, Santa Rosa and Santa Cruz.

The coast, along which we continued at a distance of two miles, is dominated by a chain of mountains parallel to the shore, and from six to seven hundred metres in elevation. At their base stretches a plain ending in vertical walls of rock, leaving between them and the sea a narrow beach of sand and pebbles. This flat country, where graze large herds of horses and cattle, is agreeably cut, at almost equal distances, by narrow valleys. In these ravines grow thick clusters of beautiful oaks, whose crowded bushy tops seem to bring to the same level all this ground: streams run through these valleys and serve to furnish water to the cattle feeding all about here. . . . .

While we went along by this shore, we found the sea almost everywhere covered with asphaltum, now in the form of round flat slabs of some thickness, now in that of large sheets of oil and tar, spread over the water and displaying yellow or blue reflections. The odor exhaled by this stuff was powerful enough to be annoying, and make breathing troublesome and difficult. I knew not for some time whether this natural pitch, spread over the entire channel in such great quantity, flowed from some point on the coast, or its source gushed up from the bottom of the sea: it was only on another stop at Santa Bárbara that I learned that half-way from this presidio to Point Concepcion, between the rancho de Los Ortegas and that of Los Dos Pueblos, there is a large pond of asphaltum boiling unceasingly, and whose excess overflows into the sea from which this spring is not far distant. . . . .

We went finally on foot to the mission ⟦Santa Barbara⟧, situated at the upper end of the plain a half-league from the presidio. The road leading to it ascends very slightly as it crosses a beautiful grassy meadow, where graze the horses used at the presidio and the cows supplying it with the daily milk. As we went on, the mission buildings presented a finer appearance. From the roadstead, we could have taken it for a mediaeval castle, with its lofty openings and belfry; approaching nearer, the building grows, and while losing none of its beauty, assumes little by little a religious aspect; the turret becomes a bell-tower; the bell, instead of announcing the arrival of a knight, rings for service or the angelus; the first illusion is destroyed, and the castle becomes a convent.

In front of the building, in the middle of a large square, is a playing fountain, whose workmanship, quite imperfect as it was, surprised us the more, the less we expected to find in this country, so far from European refinement, that kind of luxury reserved with us for the dwellings of the wealthiest. After rising to a height of more than eight feet above the ground, the clear and sparkling water of this fountain fell again in broad sheets upon a descending series of stone basins forming altogether an octagonal pyramid; it filled a reservoir of the same shape to the brim, whence, issuing from the jaws of a bear, also in stone,

* Translation by George Franklin Carter, reproduced from *Duhaut-Cilly's Account of California in the Years 1827-28*, and published by permission of California Historical Society, copyright owner. The original translation appears in the California Historical Society Quarterly volume 8, 1929.

FIGURE 250. "IN FRONT OF THE BUILDING, IN THE MIDDLE OF A LARGE SQUARE, IS A . . . . . FOUNTAIN . . . . ." *Photo from the collection of The Society of California Pioneers.*

FIGURE 251. STONE BEAR'S HEAD AS IT APPEARED IN 1951.

FIGURE 252. "WE WENT UP A FLIGHT OF SEVERAL STEPS LEADING US TO A LONG PERISTYLE OR CLOISTER, SUPPORTED BY FIFTEEN SQUARE PILLARS FORMING FOURTEEN ARCHES WHICH, FROM A DISTANCE, GIVE THE MISSION THAT NOBLE APPEARANCE WHICH SURPRISED US AT THE FIRST SIGHT OF IT . . . . ." *Photo by Watkins (new series), from the collection of The Huntington Library.*

it fell into a fine layer in stucco, around which some Indian women and California girls were busy washing. The latter looked at us from below through the beautiful tresses of their chestnut hair, and I presume the examination they made of two strangers was as perfect as it was swift.

In all countries the fair sex along possess this gift of estimating an individual, and particularly of seizing upon his oddities in a trice with a stealthy look. I saw one of these young girls smile almost imperceptibly; perhaps I myself was the cause of her mischievous mirth; but the rather grotesque appearance of my companion, his teeth calcined by the immoderate use of tobacco, and his simian head, on a slender body of four feet eight inches: all this should have quieted my self-love a little.

We went up a flight of steps leading us to a long peristyle or cloister, supported by fifteen square pillars forming fourteen arches which, from a distance, give the mission that noble appearance which surprised us at the first sight of it. . . . .

Fray Antonio Ripoll, a man of good countenance and distinguished mind, put to me some . . . . . questions . . . . .; and when I had satisfied his curiosity, or rather his anxiety, he proposed to us an inspection of the mission buildings and the church.

The facade of this chapel is ornamented with six half-columns supporting a triangular front, bearing several statues of saints. The body of the church consists only of a nave with low arched roof, without side aisles. The construction of this edifice would have been nothing to excite surprise, had it been built by Europeans; but if one consider that it is the work of poor Indians, guided by an ecclesiastic; that it is erected in a country which, though it contain all

FIGURE 253. BRICK, STONE, AND MORTAR. Santa Margarita, asistencia to Mission San Luis Obispo. *Photos from the collection of The Huntington Library.*

FIGURE 254. "THE NAVE, THE ALTAR, AND THE VESTRY ARE DECORATED WITH PAINTINGS . . . . . FROM THE HAND OF THE INDIANS THEMSELVES . . . . ." Station of the Cross painting from Mission San Gabriel. *Photo from the collection of The Huntington Library.*

the materials required, at least supplies them to the hand using them only in the rough state in which nature produces them; one cannot tire in admiration of the patience of this religious, the talent he has shown, and the care he must have taken for such a building.

With us, does one wish to undertake the erection of a building of this kind? Ten architects, with their plans and estimates, present themselves for it. One has merely to select the one most suitable; purchases are made from the furnishers; all the materials, ready to be put in place, are brought to the designated spot, without anyone having to be concerned about a single thing, other than to prove their quality and give them the finishing touch; lastly, the best workmen contend for the choice over their rivals.

Here, on the contrary, everything is in the rough, even to the men, and the first care of the builder has been to form his workmen. Out of the mere earth he has had to make bricks and tiles; to cut immense trees, far away, and to bring them, by physical strength, over roads marked out expressly across ravines and precipices; to gather, at great expense, on the seashore, shells to make into lime; finally, everything, to the most trifling, connected with this edifice, has cost preliminary labors, which must have increased the difficulty very much. One is, at the same time, astonished at the boldness of the plan and the perseverance in its execution: only a boundless zeal for the spread of religion can have made Padre Ripoll conqueror over so many obstacles. He has not, however, employed much more time for completing the building than would have been necessary in Spain. . . . .

The nave, the altar, and the vestry are decorated with paintings the best ones of which came from Mexico; the rest are from the hand of the Indians themselves. The pillars, frieze, framings and bases are marbled with a good deal of taste and decorated with arabesques passably executed. What heightens still more all this mass, and inclines one to be indulgent with regard to defects of architecture, is an excessive neatness, not found in our churches of the third and even of the second, order. . . . .

FIGURE 255. INTERIOR OF CHAPEL, ASISTENCIA SAN ANTONIO DE PALA, ABOUT 1888, SHOWING FLOOR TILE AND WALL DECORATIONS. *Photos from the collection of The Huntington Library.*

The project completely engrossing [Father Ripoll] at this time was a watermill he was having built at the foot of a hill to the right of the mission. The water, brought from more than two leagues by a canal following the side of the mountains, was to fall from a height of about twenty feet upon the buckets of a wheel. The fall of this motive power was not vertical: it worked at an angle of about 35 degrees; the wheel also, instead of being vertical was horizontal; it was a full circle, upon whose plane were arranged, like spokes, a sort of large, slightly concave spoons, which were to receive, one after another, the impulse and transmit the movement.

FIGURE 256. BAPTISMAL FONT AND WALL PAINTINGS AT SAN ANTONIO DE PALA, ASISTENCIA TO MISSION SAN LUIS REY DE FRANCIA, 1898. Edith Webb, in her paper *Pigments Used by the Mission Indians of California,* states: ". . . . . the Padres of . . . . . Mission San Gabriel included in their first *Memoria* a request for a book entitled 'Painting without an Instructor' ('un libro intitulado Pintar sin Maestro, o cosa semejante'). They also asked for a dozen brushes . . . . .That book . . . . . and the one of designs said to have been used at Mission San Miguel would be worth the proverbial king's ransom could they be found today . . . . . In 1787, Vitruvius' *De Architectura Libri Decem* were translated from the Latin into Spanish. A copy of this translation is in the Santa Barbara Mission Archives . . . . . those pages devoted to the study of pigments and their preparation for use . . . . . furnish complete instructions for the manufacture of paints from native minerals and earths . . . . . in Vitruvius' book and that one ordered in the San Gabriel *Memoria* of 1771, the Padres had all the necessary instruction for wall painting." *Photo from the collection of The Huntington Library.*

FIGURE 257. BRICK, PEBBLES, AND STONE IN THE BELL TOWER AT MISSION SAN DIEGO DE ALCALÁ, 1905. *Photo from the collection of the California Historical Society.*

At first glance I was surprised that the padre, a man of judgment, should have preferred to have the fall inclined, when it was so easy for him, in cutting a hill to a steeper slope, to make it much more powerful; for without being a hydrostatician, I readily perceived that his motive power lost the more of its force, the farther was it inclined from the vertical. But before expressing my opinion, reflection brought me back to the inventor's idea; and I believed I saw that whatever motive power he lost at first, he gained it from another side, in avoiding the friction from two sets of cog-wheels, since the turning grindstone would be fixed upon the axle of the wheel.

Another objection also can be made, in regard to the speed of rotation; for in this plan it is the same for both wheel and grindstone, while in our ordinary combination, the speed of the grindstone increases in the relation of the radius of the wheel to the radius of the axle-hub. Besides, Fray Antonio's workmen, being little skilled in mechanics, he avoided many imperfections by simplifying the machinery, and I had no doubt of the complete success of his undertaking. I brought to his attention, however, the fact that the quality of the stone he used for his grindstones, being made from the same stone, was not suitable; because being entirely composed of almost homogeneous parts, and of equal hardness, it would grow smooth too quickly. After dinner the president went to take his siesta, and we returned to the ship. . . . .

FIGURE 258. ADOBE, BRICK, AND TILE. Mission San Fernando about 1870.
Photos from the collection of The Huntington Library.

FIGURE 259. ADOBE BRICK. Mission Soledad as it appeared in 1951.

DUFLOT DE MOFRAS

Translation by Dorothy G. Jenkins

During the period when the monks were establishing the missions for the purpose of civilizing the Indians, the governors were founding military posts, called presidios, and pueblos (villages), peopled by married soldiers and white colonists who were brought from Sonora, Sinaloa, and Baja California. Since these three types of establishments, missions, presidios, and pueblos, were all developed on the same plan, it will suffice to describe one to give an idea of all the others. We shall choose as a type the mission consecrated to San Luis Rey de Francia, which is the most beautiful and most regular in architecture. (See in the Atlas the perspective, no. 23, and the geometric plan, no. 20, of the Mission San Luis Rey de Francia.)

Description of a Mission. The building is a quadrangle one hundred and fifty meters in length; the church occupies one of the wings; the façade is ornamented with a gallery. The one-story building is in general raised on a surface excavated a few feet below the ground. The interior is arranged as a court with fountains and planted with trees. Opening onto the surrounding arcade are the doors of the apartments of the monks, the managers and visitors, also of workrooms, schoolrooms, and stores. The infirmaries for men and for women are located in the quietest parts of the Mission, as are the schoolrooms. The young Indian girls are domiciled in rooms called the monastery, and they are given the name of nuns. The monks find it necessary to keep them in confinement in order to protect them from the brutality of the natives. . . . .

FIGURE 260. DETAIL OF CONSTRUCTION, MISSION SAN LUIS REY DE FRANCIA. *Photo by J. W. James, 1904, from the collection of The Huntington Library.*

FIGURE 261. ". . . . THE MISSION CONSECRATED TO SAN LUIS REY DE FRANCIA . . . . . IS THE MOST BEAUTIFUL AND MOST REGULAR IN ARCHITECTURE . . . . ." *Photo from the collection of The Huntington Library.* Newcomb, in *The Old Mission Churches and Historic Houses of California,* makes the following comments upon the mineral materials used in construction at the missions:

"Although California as an American state has within her boundaries vast resources in the way of building materials, the California of Spanish days had a comparatively meagre supply of good building material. Especially was this true of stone of durable quality, and in the south, of wood also. In the case of stone the supply for some of the missions had to be brought from a distance. Usually, however, the stones used were those nearest the site of the proposed structure, and consisted of granite boulders, taken from the washes, volcanic stones from the near-by foothills, chalkstone, limestone, and sandstone. As a general thing, the stones employed would not be considered worthy of use today in the better class of structures, but protected with stucco, as they usually were, these stones have served their purpose well.

"Lime was made either by burning limestone, which, although not of the best quality, was obtainable, or by burning sea-shells, of which there was a never-failing supply. Since all wall surfaces, inside and out, were kept whitewashed, lime was necessary at all times, and it is to be guessed that the burning of sea-shells furnished the greater part of this . . . . .

". . . . . The first temporary quarters, hastily built, were little better than brush huts with grass-thatched roofs. These were built in the fashion of the Indians and never endured long. The earliest of the buildings that can really be considered habitations were constructed of wooden posts of pine or cypress, set close together and plastered inside and out with clay. After the clay had dried the walls were treated to a heavy coat of whitewash. Usually this type of structure . . . . . was roofed with poles over which twigs were spread and upon these a layer of mud. The mud roofs were never successful in keeping out the heavy winter rains, so the Indian method of making a thatch of tule was next adopted. Thatch roofs were very inflammable and several disastrous fires were experienced before the padres . . . . . began to make burned-clay roofing tiles like those used in Spain . . . . .

"Where wood was scarce, the making of sun-dried adobe brick was early taken up. The second structure at most of the missions was of adobe. The adobe walls, due to the low bearing-power of the material, had to be very thick. Many examples are five and six feet in thickness and few are less than three feet. As soon, however, as a mission was strong and prosperous, the pride of the padre usually extended to an ambition to build a church in more lasting material, hence stone or burned brick were employed.

"Clay is available at almost any point along the coast and was used for making bricks, roofing-tiles, drains, and ollas (jugs). Most of the brick were of a red color, rather soft but durable. They were used for all purposes to which we would put brick today; for walls, arches, piers, and chimneys, and, since no wooden floors were used, for pavements of the cloisters, courts, and rooms as well. There were various forms, but the ordinary brick was flat, being about 1½" to 2" thick, and about 10" x 10" square, thus resembling the Spanish and Mexican variety.

In order to encourage the Indians to work, the Fathers often turn their own hands to labor, and they serve as examples everywhere. It was only a few years ago that Father Cavallero, president of the Dominicans, died with his hand on the plough in the midst of his neophytes at the Mission Notre Dame de Guadalupe. Necessity compelled them to be industrious; one is struck with astonishment when he sees with what poverty of resources, more often than not with no European workers, aided only by savage people with almost no intelligence and often hostile, they have succeeded, in addition to their great agricultural achievements, in executing considerable architectural and mechanical works, such as mills, machines and other devices, bridges, roads, and irrigation canals. For the construction of almost all these missions they had to bring in from distances of eight or ten leagues from the chosen spot great logs of wood cut in the most rugged mountains, and to teach the Indians to make lime, dress stones and mould bricks.

Around the mission are grouped buildings housing the various crafts, the cabins of neophytes and a few white colonists. Besides the central establishment there are, over an extent of thirty or forty square leagues, accessory farms and a few subsidiary chapels. Opposite the mission there is a military post where the monks' escort is lodged. This escort is composed of four cavalry soldiers and one sergeant; it is also used as a dispatch service to carry orders from one mission to another, and to repulse the attacks of savage tribes which, in the early days of the conquest used to harry the settlements. . . . .

Description of a Presidio. The Presidios were all built on the same plan. A favorable situation was chosen and surrounded by a ditch four meters wide and two deep. The excavated earth heaped up served as an outer rampart. The enclosure of the Presidio was formed by a quadrangle about two hundred meters in length. The rampart or wall was constructed of brick, four or five meters in height and one in thickness. Small bastions flanked the corners; the Presidio had only two portals. Generally its entire armanent consisted of eight bronze cannons of eight, twelve, and sixteen caliber. Although of insufficient strength to resist a serious attack made by ships of war, these fortifications were all that was needed to repulse incursions of Indians. Near the Presidios and in accord with the topography of the terrain, open earthworks were raised, dignified with the name *castillo* (castle). Within the enclosure of the Presidio were found the church, the lodgings of the officers and men, the houses of a few colonists, stores, workrooms, stables, wells, and cisterns. Outside were grouped a few dwellings, and at a little distance the royal farm (*el rancho del rey*), destined to furnish pasturage for the horses and beasts of burden of the garrison.

Four coast batteries and four Presidios constituted the defense of Ata California: those of San Diego, MonteRey, San Francisco, and Santa Barbara. . . . .

"Adobe, a material widely distributed in California and the Southwest, was largely employed during the mission period. It is a material that, used with judgment, will endure for many years. It was fashioned into sun-dried brick, which were made sometimes with straw as a bond, but more often depended upon the natural grog of fine particles of disintegrated rock. Brick of this sun-dried variety, laid up with mud as an adhesive, have been employed from early antiquity down to our own day, their use in Spain dating from the conquest of the Moors. The idea was carried into Mexico and California, and adobe, being easily obtainable, became a popular material throughout the province. Of course the padres knew perfectly well that walls made of adobe must be protected from the elements, hence such walls were covered with stucco. Roofs were given a wide projection in order to ward off the intense sunshine and protect the adobe walls from the weather."

FIGURE 262. MISSION SAN LUIS REY DE FRANCIA—ANCIENT ENTRANCE TO VINEYARD. *Photo from the collection of The Huntington Library.*

FIGURE 263. MISSION SAN LUIS REY DE FRANCIA—ENGAGED CIRCULAR PILLARS IN MORTUARY CHAPEL, 1905. *Photo from the collection of The Huntington Library.*

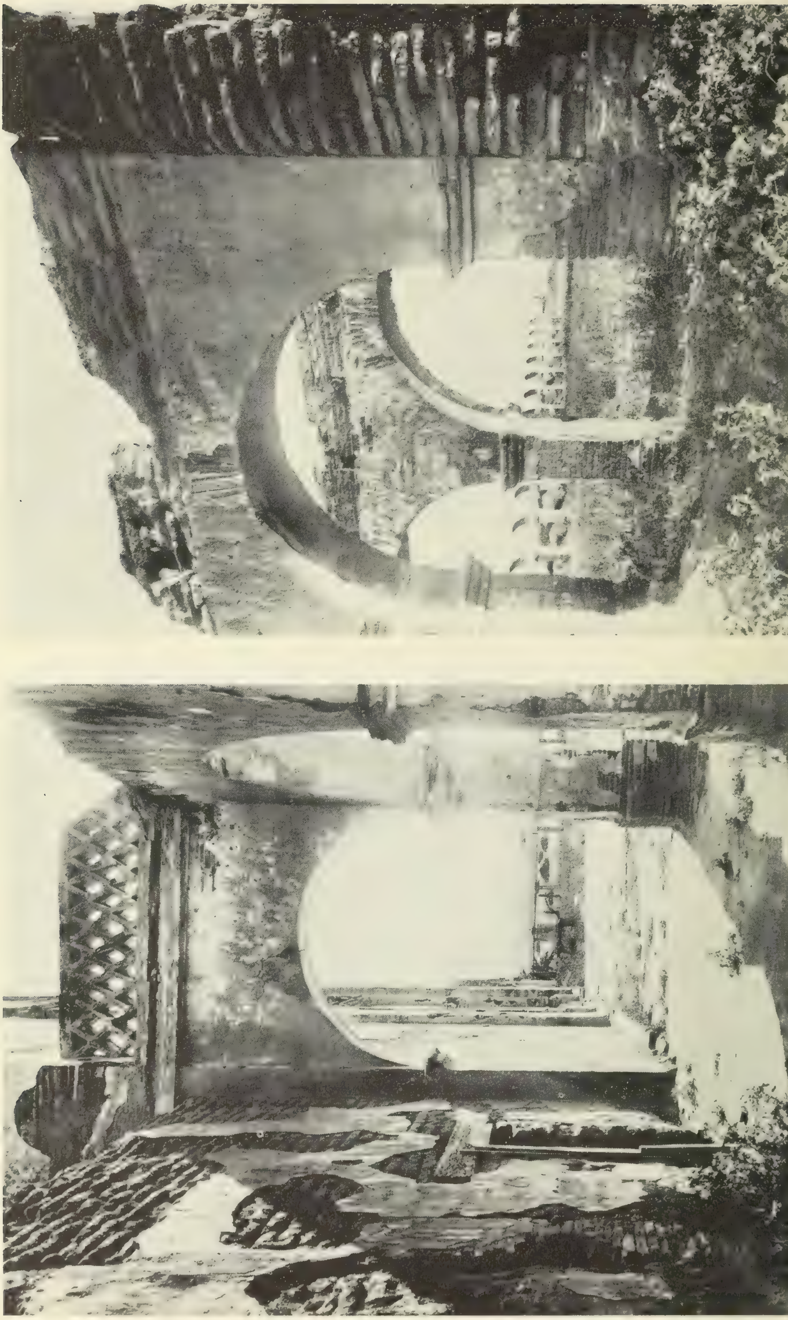


FIGURE 264.

One day when I went to see him [Fr. Tomás Esténaga, San Gabriel Mission], I found him in a field before a great table, his hood thrown aside, his sleeves pushed up, moulding clay in his hands and demonstrating to the neophytes that surrounded him, how to make bricks. As soon as he saw me he waved his hand at me, calling out: "*Amigo! con esta familia, Consilio Manuque!*" . . . . .

One of our countrymen, M. Charles Baric, who, because of his intelligence and his knowledge of the country, would be able to tender the greatest service, carries on business throughout the province, but for some time now he has been devoting himself to the exploitation of a mine of virgin gold in grains which he has discovered on the Rancho San Francisquito, six leagues in the mountains north of Mission San Fernando. This vein extends for sixteen leagues, following the course of the ravine in which it is situated. The gold is found near the surface of the ground, and some of the nuggets weigh from two to three eighths of an ounce. It is purchased in the region at fourteen piastres an ounce in money, or sixteen piastres in merchandise. At Rancho de Cahuenga, two leagues distant to the northwest of the Pueblo, there are some minerals of silver, never mined because of the lack of quicksilver and also of people with knowledge of the

---

FIGURE 264. ADOBE, BRICK, AND TILE. Mission San Luis Rey de Francia, 1900. *Photos from the collection of The Huntington Library.*

The making of adobe bricks is described by J. N. Bowman, in *Adobe Houses in the San Francisco Region,* in Division of Mines Bulletin 154, as follows:

"Adobe bricks in provincial California were made from the soil near the site of the building to be erected; the soil may have been adobe, clay, loam, or sandy or gravelly earths. Most of the adobe soil possessed sufficient adhesiveness to hold together when dried, but the other soils required a binder. The binder in the bricks of the early buildings consisted of weeds or tules, or any other vegetation at hand; later, after grains had been introduced and cultivated, the straw of wheat and barley or wild oats was used; so too was the refuse from the kitchen garbage can . . . . .

"The making of California adobe bricks was a simple process inherited from the early Spanish settlers as developed and practiced in Mexico and Spain . . . . . A convenient level spot was selected near the proposed building site and near the water supply from a spring or creek. The ground was spaded up and sometimes slightly excavated in order to hold water. When the loose earth was saturated with water, bare-legged servants, usually Indians, tramped the wet earth and the binder into a well-mixed consistency suitable for carrying to and placing in the brick moulds. On a level area nearby were the brick forms . . . . . The dimensions of the forms were usually divisions of the *vara* . . . . . about two-thirds in length and one-third in width, or about 22 by 11 inches. This size mould made the typical California adobe brick weighing 20 to 40 pounds—convenient to carry and easy to handle in the construction of the house. Some smaller forms were made for special-purpose bricks; those to be burned in the mission kilns were about 8 by 10 inches. The thickness of the brick was the depth of the mould—2 to 5 inches, on the average $3\frac{1}{2}$ inches; most bricks for the kilns were about 2 inches thick.

"After the forms had been placed in convenient rows and the earth well mixed with binder, the 'mud' was carried by hand or in baskets to the forms, tamped down with hands or feet onto the level ground and against the sides and ends of the moulds, and leveled by hand to the top of the forms. Occasionally an Indian would leave an impression of his hand or foot on the surface of a freshly packed brick, or a literate workman would print his name and the date on the surface; sometimes, too, a domestic or wild animal would leave a footprint on the adobe before it had dried.

"The bricks were allowed to dry in the sun; as soon as the tops were fairly dry, they were turned over. Then, when the underside was dry, they were taken from the forms and set on edge so that the drying process would be uniform and there would be no cracking. Finally the bricks were stacked in convenient rows to await their use in construction.

"A small one-room house required about 1,000 bricks; the typical two-room dwelling needed perhaps 2,500 bricks for its walls and partitions, and as replacements for broken or defective bricks. For very large buildings like the mission churches, priests' houses, and mills, the number of bricks needed ran into the thousands. On ranchos where a number of buildings were to be erected a 'brick yard' was established, like that of Jose de Jesus Vallejo . . . . . in the small ravine at Niles across the highway and north of the present nursery. He used the bricks in his houses and mill."

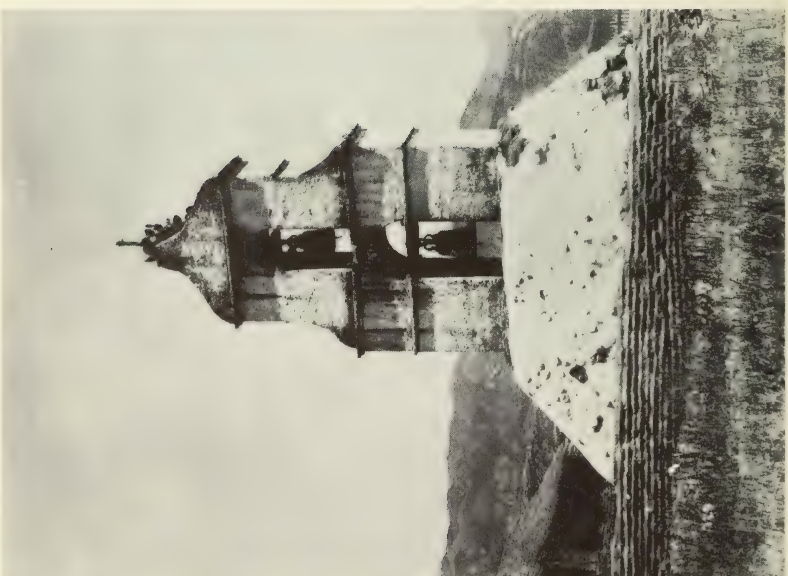


FIGURE 265. FRONT AND REAR VIEWS OF BELL TOWER, SAN ANTONIO DE PALA ASISTENCIA.
Photos from the collection of The Huntington Library.

FIGURE 266. RUINS OF STONE CHURCH, SAN JUAN CAPISTRANO MISSION, AND BELLS, AS THEY APPEARED IN 1886. *Photo from the collection of The Huntington Library.*

mining industry. The Indians often bring in, from the mountain range, grains of native copper, fragments of opal, and pieces of galena (lead sulphide).

Two leagues to the southeast there are four great seepages of asphalt, situated practically on the surface, in a broad meadow. These springs well up in the midst of little ponds of water, which is cool while the bituminous material is of a higher temperature. The water has a mineral taste, which, however, does not prevent animals from drinking it. At sunrise the orifices of these springs are covered by huge balls of asphalt, often a meter in height, resembling soap bubbles. As the air becomes warm the gas enclosed in the bell expands and the bubble bursts with a fairly loud noise. People who live in the region collect the solidified asphalt and use it to coat roofs of their houses, which are made of reeds or thin boards (shakes). This bituminous matter is also transported by boat to various distribution points. This material, however, has the disadvantage of melting in the sun, running off the roof and infiltrating the roofing material. Houses which are so covered require much in the way of upkeep, although inexpensive, since each user has to gather the material at the seepage, according to his own needs. . . . . .

In Santa Barbara channel the current comes from the north and follows the trend of the coast; the springs of asphalt that pour into the sea spread over the surface an oily and blackish film which is visible from a distance, and gives off a bituminous odor noticeable for several leagues around. . . . .

Mission Santa Barbara. Mission Santa Barbara is situated a mile from the sea and two kilometers from the Pueblo, at the foot of a range of arid mountains that protect it from winds from the east and north. Its construction is very regular: its gallery, formed by arcades, and the church with its two fine towers, are built of dressed stone. The gardens and orchards are extensive and well watered; within the mission grounds there is a great fountain, the water for which comes from the heights above and provides power for an excellent mill. In the mountains there are calcareous deposits of shells which have been used for building. This mission, narrowly enclosed between sea and mountains, has but little terrain suitable for agriculture, and it has never attained great development. . . . .

A league and a half north of Santa Barbara on the coast lies the Rancho la Brea, near which several flows of tar empty into the sea. On the beach and at

FIGURE 267. CLOSE-UP OF STONE CHURCH, MISSION SAN JUAN CAPISTRANO, AS IT APPEARED IN 1885. The building was ruined by an earthquake in 1812. *Photo from the collection of The Huntington Library.*

FIGURE 268. MISSION SAN JUAN CAPISTRANO, 1885. Interior of original baptistry of church, with original stone baptismal font, tile floor, and statues. *Photo from the collection of The Huntington Library.*

several other places hardened bituminous crusts are found. Seven leagues inland, twenty-six leagues from Los Angeles and east of the Pueblo of Santa Barbara, on the Rancho de las Pozas, there is a volcano, the slightly elevated crater of which gives forth fumes from time to time. The exhalations of this volcano are full of sulphur. At a place about a mile from the mission springs of sulphurous water are found, of which the temperature is close to that of boiling water. . . . .

. . . . . ⟦Sutter's Fort⟧ is located two miles east of the river, and one mile south of the American Fork. Between the landing and the buildings lies a lovely plain shaded by enormous oaks. Habitations could not be built on the immediate banks of the Sacramento River because of yearly floods. The Fort of New Helvetia backs on a little stream to the north, the bordering cliffs of which make a part of the defenses; the enclosure is surrounded by a wall five feet thick, made of bricks baked in the sun, and supported by huge logs: each face of the quadrangle is one hundred meters long; the angles are flanked by square bastions two stories high; each of the four sides is provided with doors and other openings, and an open gallery crowns the entire wall.

HISTORY OF MINERAL DISCOVERY AND DEVELOPMENT IN CALIFORNIA

THE ELEPHANT AS THEY SAW IT—A collection of contemporary pictures and statements on gold mining in California . . . . . assembled as a centennial supplement to the California Journal of Mines and Geology for October 1949. 128 pages, 70 illustrations, colored frontis. Price 75¢.

FABRICAS—A collection of pictures and statements on the mineral materials used in building in California prior to 1850 . . . . . assembled as a supplement to the California Journal of Mines and Geology for April 1952. 189 pages, 268 illustrations. Price $1.00.

GEOLOGIC GUIDEBOOKS

GEOLOGIC GUIDEBOOK ALONG HIGHWAY 49—THE MOTHER LODE COUNTRY. Bulletin 141, 164 pages, 2 plates, 221 figures, 10 maps. 1948. Price $1.00.

GEOLOGIC GUIDEBOOK OF THE SAN FANCISCO BAY COUNTIES. Bulletin 154, 392 pages, 1 plate, 285 figures, 7 maps. 1951. Price $2.50.

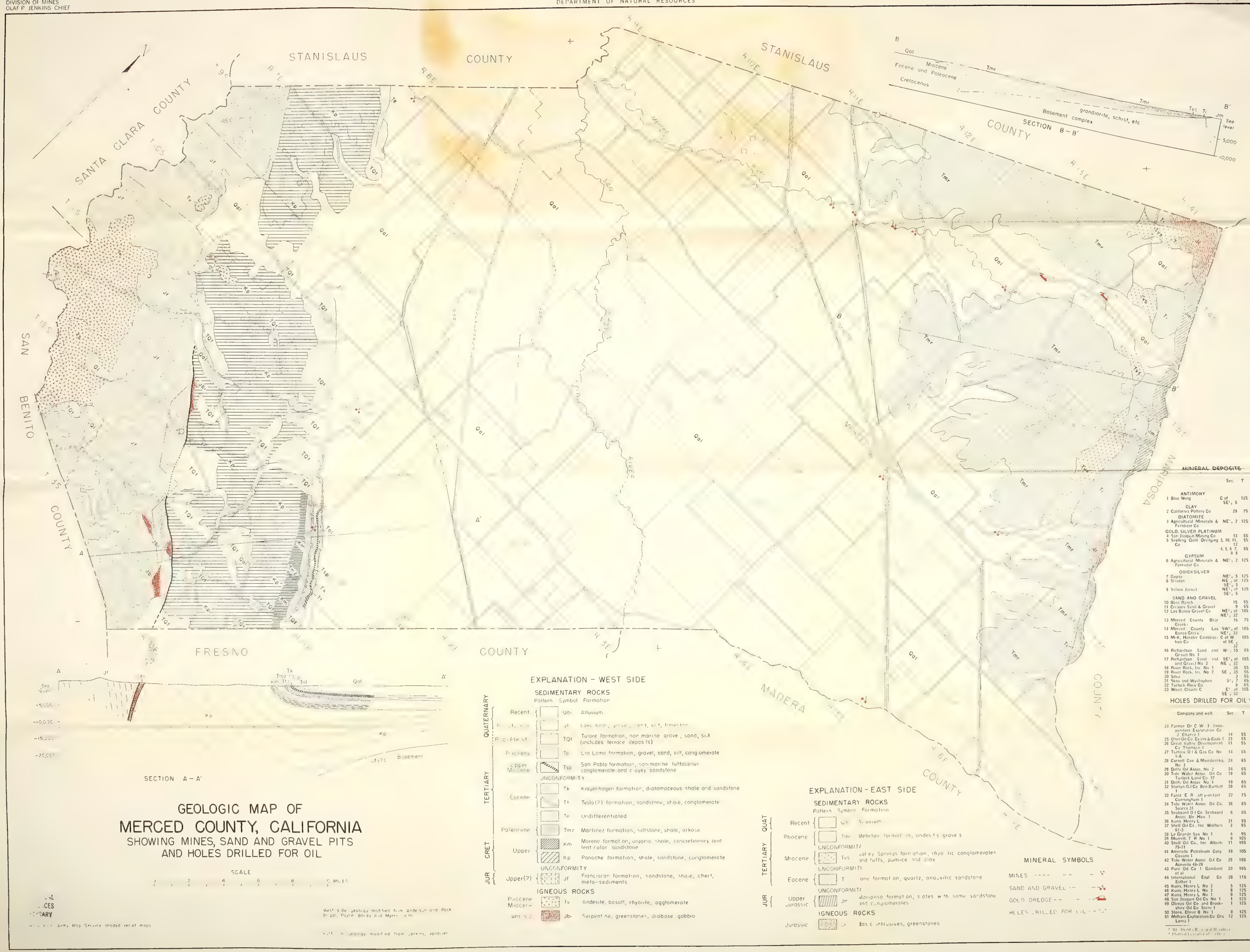
GUIDE TO THE GEOLOGY OF PFEIFFER BIG SUR STATE PARK, MONTEREY COUNTY, CALIFORNIA. Special Report 11, 16 pages, 1 plate, 28 figures. 1951. Price 25¢.

The publications listed above may be obtained from the *California State Division of Mines, Ferry Building, San Francisco 11, California.* In ordering any of these reports, please do not send currency, stamps, or personal checks; remittance should be made payable to the State Division of Mines. California residents please add 3% sales tax to orders. All prices are postpaid.

o

printed in CALIFORNIA STATE PRINTING OFFICE

54503 12-51 2M


GEOLOGIC MAP OF
MERCED COUNTY, CALIFORNIA
SHOWING MINES, SAND AND GRAVEL PITS
AND HOLES DRILLED FOR OIL
SCALE
STANISLAUS COUNTY
SANTA CLARA COUNTY
SAN BENITO COUNTY
FRESNO COUNTY
MADERA COUNTY
MARIPOSA COUNTY
SECTION A – A'
SECTION B – B'
Basement complex
granodiorite, schist, etc
Miocene
Eocene and Paleocene
Cretaceous
EXPLANATION – WEST SIDE
SEDIMENTARY ROCKS
Pattern Symbol Formation
QUATERNARY
TERTIARY
CRET
JUR
Recent
Qal Alluvium
Tulare formation, non marine gravel, sand, silt (includes terrace deposits)
San Pablo formation, non-marine tuffaceous conglomerate and clayey sandstone
UNCONFORMITY
Eocene
Tk Kreyenhagen formation, diatomaceous shale and sandstone
Tt Tesla(?) formation, sandstone, shale, conglomerate
Te Undifferentiated
Paleocene
Tmz Martinez formation, siltstone, shale, arkose
Upper
Km Moreno formation, organic shale, concretionary and lenticular sandstone
Kp Panoche formation, shale, sandstone, conglomerate
UNCONFORMITY
Upper(?)
Jf Franciscan formation, sandstone, shale, chert, meta-sediments
IGNEOUS ROCKS
Tv Andesite, basalt, rhyolite, agglomerate
Jbi Serpentine, greenstones, diabase gabbro
EXPLANATION – EAST SIDE
SEDIMENTARY ROCKS
Pattern Symbol Formation
QUAT
TERTIARY
Recent
Pliocene
UNCONFORMITY
Miocene
UNCONFORMITY
Eocene
UNCONFORMITY
Upper Jurassic
IGNEOUS ROCKS
Jurassic
MINERAL SYMBOLS
MINES
SAND AND GRAVEL
GOLD DREDGE
MINERAL DEPOSITS
ANTIMONY
CLAY
DIATOMITE
GOLD, SILVER PLATINUM
GYPSUM
QUICKSILVER
SAND AND GRAVEL
HOLES DRILLED FOR OIL

MINES AND PROSPECTS OF YUBA COUNTY, CALIFORNIA

LIST OF MINES AND PROSPECTS SHOWN ON MAP

GOLD

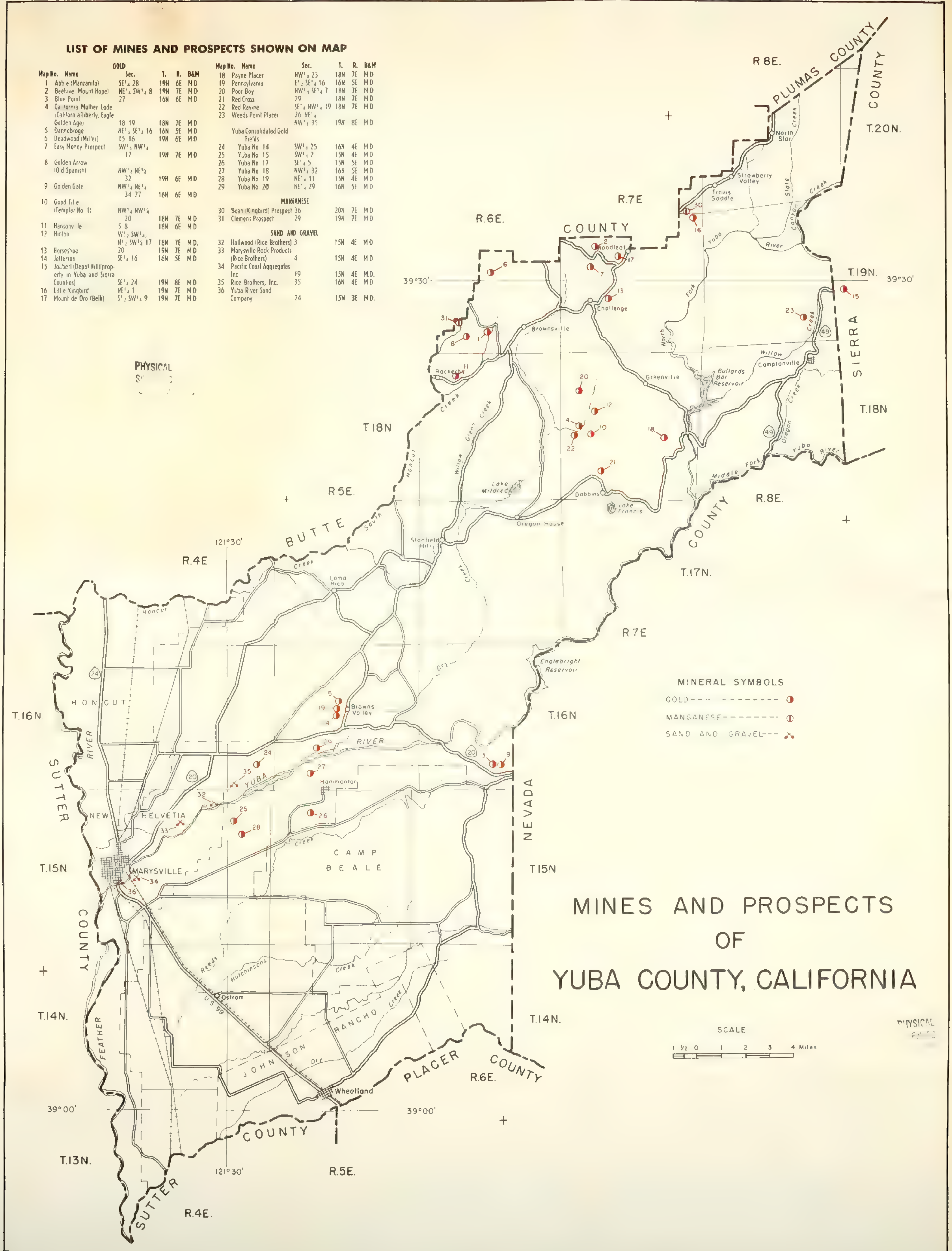
Map No.	Name	Sec.	T.	R.	B&M
1	Abbie (Manzanita)	SE¼ 28	19N	6E	M D
2	Beehive (Mount Hope)	NE¼ SW¼ 8	19N	7E	M D
3	Blue Point	27	16N	6E	M D
4	California Mother Lode (California Liberty, Eagle Golden Age)	18 19	18N	7E	M D
5	Dannebroge	NE¼ SE¼ 16	16N	5E	M D
6	Deadwood (Miller)	15 16	19N	6E	M D
7	Easy Money Prospect	SW¼ NW¼ 17	19N	7E	M D
8	Golden Arrow (Old Spanish)	NW¼ NE¼ 32	19N	6E	M D
9	Golden Gate	NW¼ NE¼ 34 27	16N	6E	M D
10	Good Title (Templar No 1)	NW¼ NW¼ 20	18N	7E	M D
11	Hansonville	5 8	18N	6E	M D
12	Hinton	W½ SW¼, N½ SW¼ 17	18N	7E	M D.
13	Horseshoe	20	19N	7E	M D
14	Jefferson	SE¼ 16	16N	5E	M D
15	Joubert (Depot Hill)(property in Yuba and Sierra Counties)	SE¼ 24	19N	8E	M D
16	Little Kingbird	NE¼ 1	19N	7E	M D
17	Mount de Oro (Belk)	S½ SW¼ 9	19N	7E	M D
18	Payne Placer	NW¼ 23	18N	7E	M D
19	Pennsylvania	E½ SE¼ 16	16N	5E	M D
20	Poor Boy	NW¼ SE¼ 7	18N	7E	M D
21	Red Cross	29	18N	7E	M D
22	Red Ravine	SE¼ NW¼ 19	18N	7E	M D
23	Weeds Point Placer	26 NE¼ NW¼ 35	19N	8E	M D
	Yuba Consolidated Gold Fields				
24	Yuba No 14	SW¼ 25	16N	4E	M D
25	Yuba No 15	SW¼ 2	15N	4E	M D
26	Yuba No. 17	SE¼ 5	15N	5E	M D
27	Yuba No 18	NW¼ 32	16N	5E	M D
28	Yuba No 19	NE¼ 11	15N	4E	M D
29	Yuba No. 20	NE¼ 29	16N	5E	M D

MANGANESE

Map No.	Name	Sec.	T.	R.	B&M
30	Bean (Kingbird) Prospect	36	20N	7E	M D
31	Clemens Prospect	29	19N	7E	M D

SAND AND GRAVEL

Map No.	Name	Sec.	T.	R.	B&M
32	Hallwood (Rice Brothers)	3	15N	4E	M D
33	Marysville Rock Products (Rice Brothers)	4	15N	4E	M D
34	Pacific Coast Aggregates Inc	19	15N	4E	M.D.
35	Rice Brothers, Inc.	35	16N	4E	M D
36	Yuba River Sand Company	24	15N	3E	M D.



INDEX TO VOLUME 48

Chapter 1, January 1952, includes pp. 3-134
Chapter 2, April 1952, includes pp. 137-179; Supplement 3-189
Chapter 3, July 1952, includes pp. 183-251
Chapter 4, October 1952, includes pp. 253-387

CONSOLIDATED TABLE OF CONTENTS

"s" following page number indicates Supplement, April, 1952

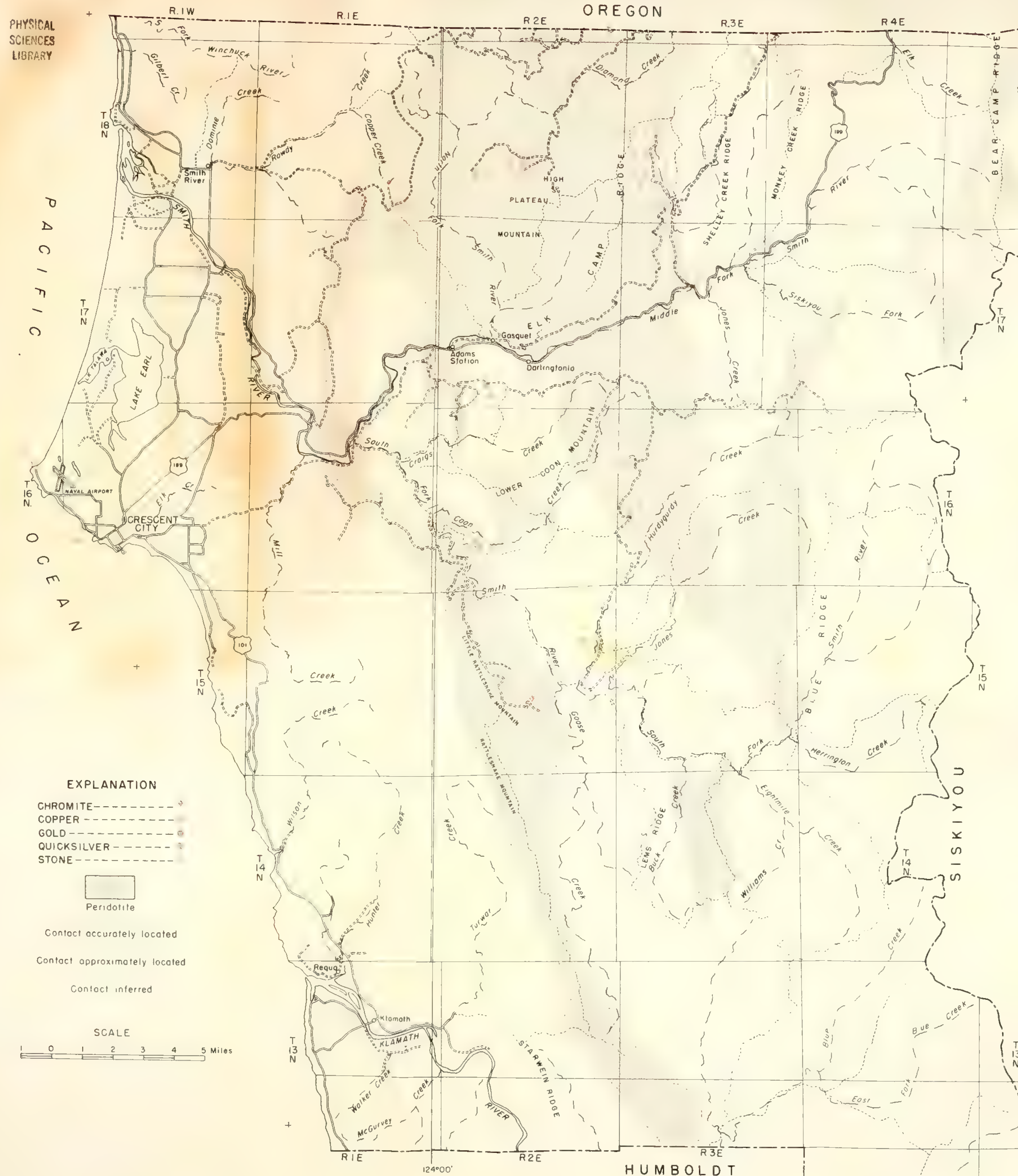
INDEX

10—64960

o

printed in CALIFORNIA STATE PRINTING OFFICE

64960 7-52 2M



LIST OF MINERAL DEPOSITS SHOWN ON MAP
DEL NORTE COUNTY, CALIFORNIA

Map No.	Property	Sec	T	R	Mineral product
		Humboldt B&M			
1	Big Dipper, Camp 7, Rowan	SW¼ 7	16N	3E	Chromite
2	Billy Boy, Hawkins, Divide	S ½ 29	16N	2E	Chromite
3	Bluebird, High Point	29	18N	2E	Chromite
4	Bonanza	SE¼ 21	18N	2E	Chromite
5	Camp 8, St. Patrick	Center 19	16N	3E	Chromite
6	Chrome Hill No. 1, The One, Hance & Webb	29	18N	3E	Chromite
7	Copper Creek, Low Divide, Rowdy Creek	SW¼ 26	18N	1E	Chromite
8	Dipper Extension	29	18N	2E	Chromite
9	Eggers	29	18N	3E	Chromite
10	Fourth of July	29	16N	2E	Chromite
11	French Hill, Tyson, J & W	NE¼ 5, 6	16N	2E	Chromite
12	High Dome, Holiday	NW¼ 21	18N	3E	Chromite
13	High Plateau	NE¼ 28	18N	2E	Chromite
14	Hole in the Ground, Sarina	NE¼ 12	18N	1E	Chromite
15	Judy, Hicks, Victory No. 2	29	18N	2E	Chromite
16	Mountain View, High Divide, Tyson	E ½ 33, W ½ 34	18N	1E	Chromite
17	Muzzle Loader, Stevens	SE¼ 4	15N	3E	Chromite
18	Old Doe	22	15N	2E	Chromite
19	Soldiers Well, McClendon	SE¼ 17	15N	2E	Chromite
20	Toujours Gai, Elk Camp	NW¼ 20	18N	3E	Chromite
21	Alta, Alta California	W ½ 35	18N	1E	Copper
22	Chicago Camp, Del Norte Camp	29	18N	6E	Copper
23	Cleopatra, Dedrick, Dietrick	3, 4	18N	2E	Copper
24	Occidental	2	17N	1E	Copper
25	Salt Lake-California, Union	35	18N	1E	Copper
26	Big Flat, Oro Grande, Oro Verde	1, 12, 13, 14	15N	2E	Gold
27	Early Ray	SE¼ SW¼ 9	17N	3E	Gold
28	French Hill	32, 33	17N	2E	Gold
29	Monumental Consolidated	1	18N	3E	Gold
30	Oak Flat and East Fork Patrick Creek	33	18N	3E	Gold
31	Big Boy	36	19N	2E	Quicksilver
32	Sunnybrook, Diamond Creek	NW¼ 11	18N	2E	Quicksilver
33	Webb, Patrick Creek, High Dome, Schutts Bros., Wilmot	SE¼ 20	18N	3E	Quicksilver
34	Basalt Rock Company	30	16N	1W	Miscellaneous stone
35	Crescent City Rock and Sand Co	11	17N	1W	Miscellaneous stone
36	Point St. George, Macco-Morrison-Knudson Co	13	16N	2W	Miscellaneous stone

MAP OF

DEL NORTE COUNTY, CALIFORNIA

SHOWING

DISTRIBUTION OF PERIDOTITE AND LOCATIONS OF MINERAL DEPOSITS

Adapted from map prepared by U.S. Geological Survey showing peridotite areas and chromite locations; Plate 1, Pl 1, Bulletin 134, 1946 California Division of Mines